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| (54) Title: MULTIPLY-SUBSTITUTED PROTEASE V. | ARIAN | ······································ |
| Novel processe variants derived from the DNA sequ. The variant processes, in general, are obtained by in vitro recombinant protesses to generate the substitution of a plus. Such variant processes have properties which are different | modifi ality of a from | I naturally-occurring or recombinant non-fluman proteases are disclussed, relation of a precusor DNA sequence encoding the naturally-occurring or annino acid residues in the annino and sequence of a precusor protease, those of the precusor protease, such as shored wash performance. The 30, 232, 252 and 257 of Bacillus amylotique/finitese subtilistin. |
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MULTIPLY-SUBSTITUTED PROTEASE VARIANTS

Related Applications

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The present application is a continuation-in-part application of United States Patent Application 08/956,323, flied October 23, 1998. United States Patent Application 08/956.564, filed October 23, 1998, and United States Patent Application 08/555,324 filed October 23, 1998, all of which are hereby incorporated herein in their entirety.

10 Background of the Invention

Serine proteases are a subgroup of carbonyl hydrolases. They comprise a diverse class of enzymes having a wide range of specificities and biological functions. Stroud. R. Sci. Amer., 131:74-88. Despite their functional diversity, the catalytic machinery of senine proteases has been approached by at least two genetically distinct families of enzymes: 1) the subtilisins and 2) the mammalian chymotrypsin-related and homologous bacterial serine proteases (e.g., trypsin and S. gresius trypsin). These two families of serine proteases show remarkably similar mechanisms of catalysis. Kraut. J. (1977). Annu. Rev. Blochem., 46:331-358. Furthermore, although the primary structure is unrelated, the tertiary structure of these two enzyme families bring together a conserved catalytic triad of amino acids consisting of serine, histotine and aspartate.

Subtillisine are serine proteases (approx. MW 27,500) which are secreted in large amounts from a wide variety of Bacillus species and other microorganisms. The protein sequence of subtilisin has been determined from at least nine different species of Bacillus. Markland, F.S., et al. (1983), Hoppe-Seyler's Z. Physiol. Chem., 364:1537-1540. The three-dimensional crystallographic structure of subtilisins from Bacillus amyloliquefaciens, Bacillus licheniforimis and several natural variants of B. lentus have been reported. These studies indicate that although subtilisin is genetically unrelated to the mammalian senne proteases, it has a similar active site structure. The x-ray crystal structures of subtilisin containing covalently bound peptide inhibitors (Robertus, J.D., et al. (1976), Biochemistry, 11:2439-2449) or product complexes (Robertus, J.D., et al. (1976), J. Biol. Chem., 251:1097-1103) have also provided information regarding the active site and putative substrate binding cleft of subtilisin. In addition, a large number of kinetic and chemical

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modification studies have been reported for subtilisin; Svendsen, B. (1976), <u>Carlsberg Res. Commun.</u>, 41:237-291; Markland, F.S. <u>id</u>) as well as at least one report wherein the side chain of methionine at residue 222 of subtilisin was converted by hydrogen peroxide to methionine-sulfoxide (Stauffer, D.C., et al. (1965), <u>J. Biol. Chem.</u>, 244:5333-5338) and extensive site-specific mutagenesis has been carried out (Wells and Estell (1988) TIBS 13:291-297)

Summary of the Invention

It is an object herein to provide a protease variant containing a substitution of an amino acid at one or more residue positions corresponding to residue positions selected from the group consisting of 62, 212, 230, 232, 252 and 257 of Bacillus amyfoliquefaciens subtillisin.

While any combination of the above listed amino acid substitutions may be amployed, the preferred protease variant enzymes of the present invention comprise the substitution of amino acid residues in the following combinations. All of the residue positions correspond to positions of Bacillus amyloliquefaciens subtilisin:

- (1) a protease variant including substitutions of the amino acid residues at position 62 and at one or more of the following positions 103, 104, 109, 159, 213, 232, 236, 245, 248 and 252;
- (2) a protease variant including substitutions of the amino acid residues at position 212 and at one or more of the following positions 12, 98, 102, 103, 104, 159, 232, 236, 245, 248 and 252.
- (3) a protease variant including substitutions of the amino acid residues at position 230 and at one or more of the following positions 68, 103, 104, 159, 232, 236 and 245;
- (4) a protease variant including substitutions of the amino acid residues at position 232 and at one or more of the following positions: 1, 9, 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275.
- 30 (5) a protease variant including substitutions of the amino acid residues at position 232 and at one or more of the following positions 103, 104, 236 and 245:
 - (6) a protease variant including substitutions of the amino acid residues at position 232 and 103 and at one or more of the following positions 1, 9, 12, 61, 62.

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68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

- (7) a protease variant including substitutions of the amino acid residues at position 232 and 104 and at one or more of the following positions 1, 9, 12, 61, 62, 5 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
 - (8) a protease variant including substitutions of the amino acid residues at position 232 and 236 and at one or more of the following positions 1, 9, 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;

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- (9) a protease variant including substitutions of the amino acid residues at position 232 and 245 and at one or more of the following positions 1, 9, 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209, 210, 212, 213, 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- (10) a protease variant including substitutions of the amino acid residues at position 232, 103, 104, 236 and 245 and at one or more of the following positions 1. 9, 12, 61, 62, 68, 76, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 205, 209: 210 212 213 217, 230, 236, 245, 248, 252, 257, 260, 270 and 275;
- (11) a protease variant including substitutions of the amino acid residues at position 252 and at one or more of the following positions 1, 9, 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270:
 - (12) a protease variant including substitutions of the amino acid residues at position 252 and at one or more of the following positions 103, 104, 236 and 245:
- (13) a protease variant including substitutions of the aming acid residues at positions 252 and 103 and at one or more of the following positions 1, 9, 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217. 232, 236, 245, 248 and 270;
- (14) a protease variant including substitutions of the amino acid residues at positions 252 and 104 and at one or more of the following positions 1, 9, 12, 61, 62. 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;
 - (15) a protease variant including substitutions of the amino acid residues at positions 252 and 236 and at one or more of the following positions 1, 9, 12, 61, 62.

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68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 236, 245, 248 and 270;

- (15) a protease variant including substitutions of the amino acid residues at positions 252 and 245 and at one or more of the following positions 1, 9, 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 213, 217, 232, 235, 245, 248 and 270.
- (17) a protease variant including substitutions of the amino acid residues at positions 252, 103, 104, 236 and 245 and at one or more of the following positions 1, 9, 12, 61, 62, 68, 97, 98, 101, 102, 103, 104, 109, 130, 131, 159, 183, 185, 210, 212, 10
 213, 217, 232, 236, 245, 248 and 270; and
 - (18) a protease variant including substitutions of the amino acid residues at position 257 and at one or more of the following positions 68, 103, 104, 205, 209, 210, 232, 236, 245 and 275 More preferred protease variants are substitution sets selected from the group consisting of residue positions corresponding to positions in Table 1 of Bacillus emyloliquefaciens subtlifisin:

Table

| | | ************ | | | | | | *************************************** | | | | | | | | | | |
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| 1 | - | | | | | | | | | | | | 245 | | 245 | 252 | | 280 |
| | | | | | | | | | | | 245 | | 236 | 252 | 236 | 248 | | 246 |
| | | - | 252 | | | | | 27.1 | 27.1 | | 236 | | 232 | 245 | 232 | 245 | 245 | C C |
| | | | 217 | 159 | 271 | 271 | 27.1 | 212 | 243 | | 232 | | 159 | 236 | 213 | 236 | 236 | 200 |
| 27.1 | 261 | 258 | 159 | 304 | 268 | 212 | 245 | 141 | 236 | 104 | 159 | 245 | 104 | 232 | 159 | 232 | 232 | 6 |
| 212 | 252 | 212 | 104 | 103 | 212 | Š | 212 | 134 | 212 | 103 | 104 104 | 232 | 103 | 159 | 30 | 159 | 159 | 4.40% |
| 20 | 104 | 104 | 103 | 9, | 104 | 103 | 104 | 104 | \$ | 76 | 103 | 104 | 9.2 | 104 | 103 | 20 | Ş | 404 |
| 103 | 103 | 103 | 7.8 | 62 | 103 | 67 | 103 | 103 | 103 | eg Gg | 76 | 103 | 68 | 103 | 78 | 103 | 103 | SV. |
| 3,6 | 22 | 76 | 47 | 12 | 78 | 92 | 76 | 76 | 76 | 22 | 80 | 76 | 24 | 99 | 88 | 99 | 99 | 200 |

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| 252 | | 252 | 252 | | | | | | | 245 | | 245 | | | | | | |
| 245 | 245 | 245 | 245 | 257 | 245 | 348 | 245 | 245 | 245 | 236 | 245 | 236 | 245 | 245 | 245 | 245 | 248 | 245 |
| 236 | 236 | 236 | 236 | 245 | 336 | 245 | 236 | 236 | 237 | 232 | 236 | 232 | 236 | 236 | 236 | 236 | 245 | 236 |
| 232 | 232 | 232 | 232 | 236 | 232 | 236 | 232 | 232 | 236 | 159 | 232 | 206 | 232 | 232 | 232 | 232 | 236 | 232 |
| 159 | 129 | 159 | 159 | 232 | 159 | 232 | 159 | 203 | 232 | 104 | 35 | 174 | 188 | 230 | 159 | 215 | 232 | 159 |
| 9 | \$ | 20, | 90 | 159 | 116 | 159 | 50 | 159 | 159 | 103 | 159 | 159 | 159 | 159 | 104 | 159 | 159 | 201 |
| 103 | 103 | 103 | 103 | 104 | 104 | 101 | 103 | 104 | Ş | 79 | ţ0, | 104 | 104 | 104 | 103 | 2 | 104 | 103 |
| 88 | 88 | 88 | 87 | 103 | 103 | 103 | 68 | 103 | 103 | 76 | 103 | 103 | 103 | 103 | 86 | 103 | 103 | 76 |
| 43 | 43 | 43 | 68 | 88 | 88 | 88 | ů, | 89 | 88 | 85 | 88 | 88 | 83 | 88 | 88 | 88 | 83 | 88 |

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| 245 | 257 | | 275 | | 257 | A STATE OF THE PERSONS | 245 | 245 | 236 | 245 | 245 | 245 | 245 | 261 | | 245 | 236 | |
| 236 | 245 | ************ | 257 | | 245 | 257 | 236 | 236 | 232 | 236 | 236 | 236 | 236 | 245 | | 236 | 232 | |
| 232 | 236 | 257 | 245 | | 236 | 245 | 232 | 232 | 214 | 232 | 232 | 232 | 232 | 236 | 245 | 232 | 159 | |
| 210 | 232 | 245 | 236 | | 232 | 336 | 209 | 211 | 159 | 215 | 159 | 159 | 159 | 232 | 242 | 210 | 20. | 245 |
| 159 | 159 | 236 | 232 | 275 | 22.4 | 232 | 159 | 159 | 10. | 159 | 104 | 104 | 104 | 159 | 236 | 159 | 103 | 236 |
| 104 | 70 | 232 | 159 | 257 | 159 | 129 | 104 | 104 | 103 | 104 | 103 | 103 | 103 | 2 | 232 | 104 | 76 | 232 |
| 103 | 103 | 104 | 104 | 104 | 104 | 104 | 103 | 103 | 36 | 103 | 92 | 76 | 7.6 | 103 | 100 | 103 | 638 | 104 |
| 7.6 | 76 | 103 | 103 | 103 | 103 | 103 | 92 | 76 | 88 | 9/ | 88 | 68 | 87 | 76 | 103 | 76 | 82 | 103 |
| 88 | 98 | 76 | 68 | 22 | 93 | 92 | 88 | 638 | 22 | 88 | 12 | 8 | 53 | 88 | 92 | 63 | 53 | 73 |

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| | 248 | 245 | 236 | 256 | 245 | 245 | 232 | 248 | 248 | 248 | 245 | | 248 | 248 | 248 | 248 | 252 | 248 |
| 245 | 245 | 236 | 232 | 245 | 236 | 236 | 185 | 245 | 245 | 345 | 236 | 252 | 245 | 245 | 245 | 245 | 248 | 245 |
| 236 | 236 | 232 | 206 | 236 | 232 | 232 | 170 | 236 | 236 | 236 | 232 | 248 | 236 | 236 | 236 | 236 | 245 | 236 |
| 232 | 232 | 159 | 183 | 232 | 206 | 129 | 159 | 232 | 232 | 232 | 184 | 245 | 232 | 232 | 232 | 232 | 238 | 232 |
| 192 | 159 | 104 | 159 | 159 | 159 | 20 | 116 | 159 | 159 | 212 | 159 | 236 | 203 | 159 | 159 | 209 | 232 | 185 |
| 159 | 147 | 103 | 104 | 104 | 104 | 103 | 104 | 104 | 104 | 159 | 88 | 232 | 159 | 109 | 104 | 159 | 159 | 159 |
| 104 | 104 | 78 | 103 | 103 | 103 | 76 | 103 | 103 | 103 | 104 | 104 | 159 | 104 | 104 | 103 | \$ | 104 | 104 |
| 103 | 103 | 88 | 26 | 22 | 76 | 98 | 92 | 33 | 88 | 103 | 103 | 104 | ŧ | 103 | 99 | 103 | 103 | 103 |
| 78 | 76 | 12 | 99 | 88 | 88 | 22 | 88 | 63 | 63 | 88 | 88 | 103 | 88 | 88 | 20 | 88 | 99 | 68 |

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| 245 | 236 | 245 | 245 | 248 | 245 | 245 | 245 | 245 | 248 | 245 | 248 | 245 | 248 | 248 | 248 | 248 | 248 | 245 |
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| 232 | 210 | 232 | 232 | 236 | 232 | 232 | 232 | 232 | 236 | 232 | 236 | 232 | 236 | 236 | 236 | 236 | 236 | 232 |
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| 159 | 159 | 159 | 159 | 213 | 159 | 159 | 104 | 158 | 159 | 159 | 159 | 104 | 159 | 159 | 159 | 159 | 159 | 104 |
| 104 | 104 | 104 | 104 | ğ | 104 | 104 | 103 | 104 | 20 | 104 | 104 | 103 | 104 | 2 | 104 | 104 | 104 | 103 |
| 103 | ğ | 103 | 103 | 103 | 103 | 53 | 88 | 103 | 103 | 103 | 103 | 88 | 103 | 103 | 103 | 63 | 103 | 89 |
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| 248 | 252 | 252 | 248 | | | 252 | 248 | 252 | 232 | 248 | 245 | 232 | 245 | | 245 | 238 | 248 | 252 |
| 245 | 248 | 348 | 245 | 252 | 252 | 248 | 245 | 248 | 218 | 245 | 236 | 213 | 236 | 245 | 238 | 232 | 245 | 248 |
| 236 | 245 | 245 | 536 | 248 | 248 | 245 | 236 | 245 | 213 | 236 | 232 | 210 | 232 | 236 | 232 | 159 | 236 | 245 |
| 232 | 236 | 236 | 232 | 245 | 245 | 236 | 232 | 236 | 159 | 232 | 158 | 159 | 159 | 232 | 159 | 137 | 232 | 236 |
| 159 | 232 | 232 | 159 | 236 | 238 | 232 | 159 | 232 | 20 | 228 | 104 | 25 | 104 | 210 | 130 | 133 | 651 | 232 |
| 116 | 159 | 159 | \$ | 232 | 232 | 159 | \$ | 159 | 103 | 159 | 103 | 103 | 103 | 205 | 104 | 104 | 133 | 159 |
| 104 | 20, | 104 | 103 | 2 | 159 | 104 | 103 | 2 | 101 | 100 | 76 | 58 | 76 | 159 | 103 | 103 | 104 | 3 |
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| 232 | 190 | 104 | 167 | 336 | 236 | 236 | 236 | 236 | 236 | 336 | 248 | 236 | 236 | 236 | 236 | 213 | 232 | 232 |
| 218 | 158 | 183 | 159 | 232 | 232 | 232 | 232 | 232 | 232 | 232 | 236 | 232 | 232 | 232 | 232 | 651 | 233 | 217 |
| 159 | 104 | 92 | 104 | 169 | 159 | 155 | 159 | 159 | 159 | 159 | 232 | 159 | 184 | 166 | 212 | 104 | 159 | 506 |
| 2 | 103 | 88 | 103 | 104 | 104 | 104 | 104 | 104 | 106 | 108 | 159 | 104 | 159 | 159 | 159 | 103 | ÷0; | 159 |
| 501 | 88 | е Т | 68 | 103 | 103 | 103 | 103 | 103 | 104 | 104 | 104 | 103 | 104 | 104 | 104 | 62 | 103 | 104 |
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| 248 | 252 | 252 | 252 | 252 | 245 | 245 | 236 | 236 | 236 | 245 | 260 | 260 | | | | | | |
| 245 | 248 | 248 | 248 | 248 | 236 | 236 | 232 | 232 | 232 | 236 | 245 | 245 | 245 | 345 | 245 | 245 | 245 | 245 |
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| 104 | 130 | 131 | ğ | \$ | 103 | 103 | 103 | 103 | 103 | 103 | 104 | 104 | 104 | 104 | 104 | 2 | 104 | ğ |
| 103 | 104 | \$ | 133 | 55 | 76 | 78 | 76 | 7.6 | 76 | 76 | 103 | 103 | 103 | 103 | 103 | 103 | 103 | 103 |
| 62 | 103 | 103 | 22 | 38 | 33 | 88 | 88 | 88 | 99 | 88 | 68 | 76 | 88 | 99 | 88 | 68 | 68 | 68 |

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| | | 290 | | 245 | 245 | 245 | | 336 | 257 | 780 | 248 | 257 | 232 | 536 | | 236 | 245 | 232 | |
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| | 245 | 236 | 245 | 232 | 232 | 232 | 245 | 213 | 236 | 336 | 236 | 236 | 210 | 213 | 245 | 213 | 232 | 209 | |
| | 236 | 232 | 236 | 17.4 | 164 | 508 | 236 | 159 | 232 | 232 | 232 | 232 | 159 | 208 | 236 | 210 | 209 | 205 | |
| | 230 | 159 | 232 | 159 | 159 | 159 | 232 | 104 | 159 | 213 | 210 | 508 | 104 | 159 | 232 | 205 | 205 | 159 | |
| | 159 | 104 | 159 | 104 | 104 | 104 | 159 | 103 | 2 | 159 | 156 | 159 | 103 | 104 | 200 | 158 | 159 | ã | - |
| | ģ | 103 | 2 | 103 | 103 | 103 | 9 | 76 | 103 | 20 | <u>\$</u> | \$ | 7.6 | 103 | \$ | 5 | 20 | 103 | |
| | 103 | 88 | 103 | 89 | 88 | 98 | 103 | 88 | 88 | 103 | 103 | 103 | 68 | 2 | 103 | 103 | 103 | 88 | |

| | | | - | | | | | | i | | | | | | | | | |
|-----|-----|-----|-----|-----|--|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | | | | | | | | | | | | | | | | | | |
| | 260 | | | | i de de la constante de la con | | | - | | | 252 | 252 | 252 | | | | | 256 |
| | 245 | | | | | | | 252 | 261 | 252 | 248 | 248 | 248 | 252 | | | | 252 |
| 257 | 236 | 245 | | | | | 245 | 248 | 257 | 248 | 245 | 245 | 245 | 248 | 252 | 252 | 252 | 248 |
| 245 | 232 | 236 | 245 | 245 | 245 | | 236 | 245 | 245 | 245 | 236 | 236 | 236 | 245 | 248 | 248 | 248 | 245 |
| 236 | 210 | 232 | 236 | 236 | 236 | 245 | 232 | 236 | 236 | 236 | 232 | 232 | 232 | 238 | 245 | 245 | 245 | 236 |
| 232 | 208 | 210 | 232 | 232 | 232 | 236 | 209 | 232 | 232 | 232 | 212 | 212 | 212 | 232 | 236 | 236 | 244 | 232 |
| 208 | 302 | 208 | 210 | 210 | 159 | 230 | 159 | 158 | 159 | 212 | 159 | 159 | 158 | 213 | 232 | 232 | 236 | 213 |
| 205 | 159 | 205 | 209 | 205 | 128 | 159 | 104 | 101 | 104 | 159 | \$ | 104 | 104 | 159 | 159 | 184 | 232 | 159 |
| 159 | 102 | 159 | 159 | 159 | 20 | \$ | 103 | 103 | 103 | 101 | 103 | 103 | 103 | ğ | 133 | 159 | 159 | ğ |
| 104 | 103 | 100 | 104 | 104 | 103 | 103 | 88 | 88 | 53 | 103 | 102 | 402 | 707 | 103 | 104 | 104 | 103 | 103 |
| 103 | 89 | 23 | 103 | 103 | 88 | 48 | 48 | 48 | 48 | 102 | ŧ | 101 | 88 | 505 | 103 | 103 | 103 | 82 |

| | i | i | | | | | | | | | | 1 | | T | T | | 1 | |
|-----|-----|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | | | | | | | | | | 252 | | | | | | | | |
| 252 | | *************************************** | | | i | 252 | | 252 | 252 | 248 | | | 252 | | | 252 | 252 | 252 |
| 248 | 252 | 252 | 252 | 252 | 252 | 248 | 252 | 248 | 248 | 245 | | | 248 | 252 | 252 | 248 | 248 | 248 |
| 245 | 248 | 248 | 348 | 248 | 248 | 245 | 248 | 248 | 245 | 236 | | | 245 | 248 | 248 | 245 | 346 | 245 |
| 236 | 245 | 245 | 245 | 245 | 245 | 238 | 236 | 236 | 236 | 232 | | | 236 | 245 | 245 | 236 | 236 | 236 |
| 232 | 236 | 236 | 336 | 236 | 236 | 232 | 232 | 232 | 232 | 213 | 262 | | 232 | 236 | 236 | 232 | 232 | 232 |
| 213 | 232 | 232 | 232 | 232 | 232 | 212 | 212 | 213 | 213 | 212 | 248 | | 213 | 232 | 232 | 213 | 213 | 213 |
| 159 | 185 | 902 | 213 | 159 | 159 | 159 | 159 | 159 | 212 | 159 | 245 | 245 | 159 | 159 | 159 | 159 | 159 | 159 |
| ğ | 159 | 159 | 159 | 104 | \$ | 104 | 104 | 109 | 159 | 104 | 232 | 230 | 130 | 130 | 128 | 104 | 128 | 128 |
| 103 | 104 | 104 | 107 | 103 | 103 | 103 | 103 | 104 | 104 | 103 | 159 | 159 | 104 | 104 | 104 | 103 | 107 | 104 |
| 82 | 103 | 103 | 103 | 102 | 102 | 102 | 102 | 103 | 103 | 101 | 10 | 104 | 103 | 103 | 103 | 101 | 103 | 103 |
| 12 | 101 | 101 | 101 | 88 | 101 | 98 | 800 | 62 | 62 | 62 | 103 | 103 | 29 | 101 | 101 | 62 | 63 | 3 |

| | | | ************** | | | | | | | | e descharacean and an a | 27.1 |
|-----|-----|-----|-----------------|-----|-----|-----|-----|-----|-----|-----|-------------------------|------|
| | | | annament of the | | | | | | | | | 252 |
| | | | | | | | | | | 252 | | 248 |
| 260 | 252 | 252 | 252 | 252 | 252 | 252 | 252 | | 252 | 248 | 252 | 245 |
| 252 | 248 | 248 | 248 | 248 | 248 | 248 | 248 | | 248 | 245 | 248 | 236 |
| 248 | 245 | 245 | 245 | 245 | 245 | 245 | 245 | | 245 | 236 | 245 | 232 |
| 245 | 236 | 236 | 236 | 236 | 236 | 236 | 236 | 245 | 236 | 232 | 236 | 213 |
| 236 | 232 | 232 | 232 | 232 | 232 | 232 | 232 | 236 | 232 | 184 | 232 | 508 |
| 232 | 159 | 129 | 159 | 212 | 503 | 210 | 202 | 230 | 194 | 159 | 230 | 185 |
| 159 | 133 | 104 | 104 | 159 | 159 | 159 | 159 | 159 | 159 | 104 | 159 | 159 |
| Š | 104 | 103 | 103 | 104 | 104 | 104 | 104 | 104 | 102 | 103 | 104 | 104 |
| 103 | 103 | 101 | 101 | 103 | 103 | 103 | 103 | 103 | 103 | 101 | 103 | 103 |
| 101 | 5 | 88 | 66 | 101 | 101 | 101 | 101 | 101 | 101 | 92 | 101 | 62 |
| | à | | | | | | | | | hi | | |

- 17 -

Most preferred protease variants are substitution sets selected from the group consisting of residue positions corresponding to positions in Table 2 of Bacilius amyloliquefaciens subtilisin:

Table 2

| C92N | S103A | V104I | S212P | £271V | | | | | | - | - | |
|------|-------|-------|--------|---|-------|-------|-------|-------|--------|---|---|----------|
| M76D | S103A | V1048 | N252K | NZ61Y | | | | | | | | |
| Q92N | S103A | V104 | \$212P | G258R | | | | | | - | | |
| V4E | 09/N | S103A | V104I | G159D | L217E | N252D | | | | | | |
| O12H | N62H | N76D | S103A | V104! | G159D | | | | | | | |
| N76D | S103A | V104i | S212P | V268F | E271V | | | | | | - | |
| N76D | S87R | S103A | V1041 | S212P | E271V | | | | | | | <u>-</u> |
| 09ZN | S103A | V104I | \$212P | Q245L | E271V | | | | | | - | |
| N76D | S103A | V1048 | T134S | S141N | S212P | E271V | | | | | | |
| N76D | S103A | V104 | S212P | Q236L | N243S | E271V | | | | | | |
| G20V | N62S | N78D | S103A | V104I | | | | | | | | |
| V68A | N76D | S103A | V1041 | G159D | A232V | Q236H | Q245R | | | | | |
| N76D | S103A | V104 | A232V | O245R | | | | | | | | |
| S24T | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | |
| V68A | S103A | V104I | G159D | A232V | G236H | Q245R | N252K | | | | | |
| V68A | N76D | S103A | V1041 | G159D | T213R | A232V | O236H | Q245R | T260A | | | 7 |
| V68A | S103A | V104! | G159D | A232V | G236H | Q245R | N248D | N252K | | | | |
| V68A | STOBA | V104 | G159D | A232V | G236H | Q245R | | | | | | |
| V68A | S103A | 7104 | N140D | N140D G159D A232V Q236H Q245R N252K | A232V | O236H | O245R | N252K | ****** | | | - |

| N43S | V68A | S103A | V104 | G159D | A232V | O236H | Q245R | N252K | | |
|------|-------|-------|-------|-------------|-------|-------------|-------|-------|---|---|
| N43K | V68A | S103A | V104I | G159D | A232V | Q236H | 0245R | | | |
| N43D | V68A | S103A | V104 | G159D | A232V | QZ36H | Q245R | N252K | *************************************** | |
| V68A | S87G | S103A | V104I | G159D | A232V | Q236H | O245R | N252K | RZ75S | - |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q236H Q245R | 12577 | | - | |
| V68A | S103A | V104I | N116D | G159D | A232V | O236H | Q245R | | | |
| V68A | S103A | V104I | G159D | A232V | Ф236Н | Q245R | N248D | | | |
| R10C | V68A | S103A | V1048 | G159D | A232V | Q236H | Q245R | | | |
| V68A | S103A | V104 | G159D | V203E | A232V | О236Н | O245R | | | |
| V68A | S103A | V104 | G159D | A232V | Q236H | K237E | Q245R | | | |
| V68A | 09/N | N873 | S103A | V104f | G159D | A232V | Q236H | Q245R | | |
| V68A | S103A | V104! | G159D | N183D | A232V | Q236H | Q245R | | | |
| V68A | S103A | V104 | G159D | A174V | 02061 | A232V | Q236H | Q245R | | |
| V68A | S103A | V1041 | G159D | S188C | A232V | Q236H | Q245R | | | |
| V68A | S103A | V104I | G159D | A230T | A232V | Q236H | Q245R | | | |
| V68A | A98T | S103A | V10# | G159D | A232V | Q236H | Q245R | | | |
| V68A | S103A | V104I | G159D | A215T | A232V | C236H | Q245R | | | 1 |
| V68A | S103A | V104 | G159D | A232V | Q236H | O245R | N248S | | | |
| V88A | N78D | S103A | V104 | G159D A232V | | O236H G245R | Q245R | | | |

| VEBA | N76D | S103A | V1048 | G159D | P210R | A232V | A232V 0236H | Q245R | **** | |
|------|-------|-------|-------|-------|-------|--------|-------------------|--------|--------|--|
| V68A | N76D | S103A | V104 | G159D | A232V | O236H | Q245R | 1.2577 | | |
| N76D | S103A | V1041 | A232V | О236Н | Q245R | 1.2577 | | | | |
| V68A | S103A | V1041 | G159D | A232V | Q236H | Q245R | L257V | R275H | | |
| N76D | S103A | V104! | L257V | R275H | | | | | | |
| V68A | S103A | V104j | G159D | T224A | A232V | Q236H | Q245R | L257V | | |
| 09/N | S103A | ٧١٥٤ | G159D | A232V | Q236H | Q245R | L257V | | | |
| V68A | 092N | S103A | V104I | G159D | Y209W | A232V | Q236H | Q245R | | |
| V68A | M76D | S103A | V104 | G159D | G211R | A232V | Q236H | O245R | | |
| VESA | N76D | S103A | V104I | G159D | G211V | A232V | Q236H | Q245R | | |
| Q12R | V68A | N76D | S103A | V1041 | G159D | Y214L | A232V | Q236H | 0245R | |
| V68A | N76D | S103A | V104I | G159D | A215R | A232V | O235H | Q245R | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | A232V | О236Н | O245R | | |
| G20R | V68A | N76D | S103A | V104f | G159D | A232V | Q236H | O245R | \$259G | |
| V68A | S87R | C92N | S103A | V1048 | G159D | A232V | Q236H | Q245R | T260V | |
| V68A | 09ZN | S103A | V104I | G159D | A232V | Q236H | Q245R | N261G | | |
| V68A | 097N | S103A | V104I | G159D | A232V | Q236H | Q245R | NZ61W | | |
| N76D | S103A | V104 | A232V | Q238H | S242P | Q245R | | | | |
| V68A | M7RD | 83038 | V1041 | G159D | P2101 | VCECA | A232V 0236H 0245R | O245R | ***** | |

| Q12R | A48V | V68A | 092N | S103A | V104I | G159D | A232V | Q236H | 0245R | | |
|-------|-------|---------|-------|-------|-------|--------|-------------------|-------------------------|-------|-------|--|
| U3/N | S103A | V104 | A232V | Q236H | Q245R | | | | | | |
| 09/N | S103A | V1041 | G159D | Y192F | A232V | Q236H | 0245R | | | | ********** |
| 09ZN | S103A | V104I | V1478 | G159D | A232V | C236H | G245R | Q245R N248S | K251R | | |
| Q12R | V68A | N76D | S103A | V104I | G159D | A232V | Q236H | Q245R | A272S | | *************************************** |
| V68A | N76D | S103A | V1048 | G159D | N183K | Q2081. | A232V | Q236H | Q245R | | |
| V68A | U35N | S103A | V1048 | G159D | A232V | Q236H | Q245R | \$256R | 10000 | | |
| V68A | 097N | S103A | V1048 | G159D | Q206R | A232V | Q236H | Q245R | | | and the same of th |
| K27R | V68A | N76D | S103A | V1048 | G159D | A232V | Q236H | C245R | | | *************************************** |
| V68A | N76D | S103A | V1048 | N1167 | G159D | R170S | N185S | A232V | O236H | O245R | of the second contract of the |
| G61E | V68A | S103A | V1048 | G159D | A232V | C236H | O245R | N248D | N252K | | |
| N43D | V68A | S103A | V1048 | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | S212P | A232V | Q236H | Q245R | N248D | M252K | | |
| V68A | S103A | V104I | Seen | G159D | N184D | A232V | Q236H | Q245R | N248D | N252K | *************************************** |
| S103A | V104 | G159D | A232V | O236H | Q245R | N248D | N252K | | | | |
| V68A | S103A | V1041 | G159D | Y209W | A232V | G236H | Q236H Q245R | N248D | N252K | | |
| V68A | S103A | V104E | Q109R | G159D | A232V | | Q236H Q245R | N248D | N252K | | |
| G20R | V68A | S103A | V1041 | G159D | A232V | Q236H | G236H G245R N248D | N248D | N252K | | |
| 1,600 | \$403 | 1570.88 | Ctron | ADUGA | 20204 | COSCI | COARD | YCZEN COASE NOARD NOSCO | MORCH | | |

| V68A | S103A | V104i | G159D | A232V | O236H | O245R | N248D | N252K | N261D | *************************************** | |
|------|--------|--------|-------|--------|--------|---------------|-----------------------|-------|-------|---|---|
| V68A | S103A | V104 | G159D | N185D | A232V | O236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104I | G159D | P210R | A232V | Q236H | O245R | N248D | N252K | | |
| V68A | S103A | V104! | G159D | P210T | A232V | Q236H | G245R | N248D | N252K | | |
| V68A | S103A | V1041 | G159D | P210S | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V1041 | G159D | N185D | P2101. | A232V | Q236H | Q245R | N248D | N252K | - |
| V68A | \$103A | V1041 | G159D | P210L | A232V | Q236H | O245R | N248D | N252K | | |
| V68A | S103A | V104] | G159D | S212A | A232V | Q236H | Q245R | N248D | N252K | | - |
| V68A | S103A | V104I | G159D | \$2126 | A232V | Q236H | Q245R N248D | N248D | N252K | | |
| V68A | S103A | V104I | G159D | \$212E | A232V | Q236H | Q236H Q245R | N248D | N252K | | |
| V68A | S103A | V1041 | G159D | 1213E | A232V | Q236H Q245R | Q245R | N248D | N262K | | |
| V68A | S103A | V1048 | T213S | A232V | Q236H | O245R | N248D | N252K | | | |
| V68A | A103V | V104 | G159D | T213E | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104 | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | - |
| V68A | S103A | V104I | G159D | 72136 | A232V | Q236H | Q245R | N248D | N252K | *** | |
| V68A | S103A | V104 | G159D | A215V | A232V | Q236H | Q245R | N248D | N252K | | |
| VEBA | S103A | V1041 | G159D | A215R | A232V | O236H | Q245R | N248D | N252K | | |
| VEBA | S103A | V 1041 | G159D | S216T | A232V | Q238H | Q245R | N248D | N252K | | |
| V68A | S103A | 7104 | G159D | \$216V | A232V | Q236H | Q236H Q245R N248D | N248D | N252K | | |

| V1048 | G159D | S216C | A232V | A232V G236H G245R N248D | Q245R | N248D | N252K | | | |
|-------|----------------------------------|-------|---|---|---|--|--|-----------------------------|---|--|
| | Section Management | | | | | | | | | 7 |
| S103A | V104 | G159D | A232V | O236H | O236H O245R | N248D | N252K | | | |
| V104I | G159D | N173D | A232V | G236H | Q245R | N248D | N252K | | | |
| V104I | G159D | A232V | Q236H | Q245R | N248D | K251V | N252K | | | |
| V104I | G159D | C206R | A232V | Q236H | Q245R | N248D | N252K | or the second second second | | Ì |
| V104I | G159D | A232V | Q236H | O245R | N248D | N252F | | | | |
| V104I | G159D | A232V | О236Н | Q245R | N248D | N252L | 1 | | | *************************************** |
| S103A | V104! | G159D | A232V | Q236H | Q245R | N248D | N252F | | | |
| V104I | G159D | A232V | Q236H | Q245R | N248D | NZ52K | T255V | | | *************************************** |
| V104I | G159D | A232V | Q236H | Q245R | N248D | NZ52K | S256N | | | |
| V104I | G159D | A232V | Q236H | O245R | N248D | N252K | S256E | | | |
| V104I | G159D | A232V | Q236H | Q245R | N248D | N252K | S256R | | | |
| V104I | G159D | A232V | Q236H | Q246R | M248D | N252K | T260R | | | *************************************** |
| V104I | G159D | A232V | Q236H | Q245R | N248D | N262K | L257R | | | |
| V104(| G159D | A232V | Q236H | O245R | N248D | N252K | G258D | | | |
| S103A | V1048 | G159D | A232V | Q236H | Q245R | N248D | N252K | 069ZN | | |
| V104t | N116S | G159D | A232V | О236Н | Q245R | N248D | N252K | T260E | | |
| V104i | G159D | A232V | Q236H | Q245R | N248D | N252K | N261R | | | |
| V1041 | G159D | A232V | Q236H | Q245R | N248D | N252K | N261D | | | |
| | V1041 V1041 V1041 V1041 | | G159D G159D G159D V104I N116S G159D G159D | G1580 A232V G1590 A232V G1590 A232V V104 G1580 N116S G1580 G1590 A232V G1590 A232V | G1590 A232V Q238H G1590 A232V Q238H V104 G1590 A232V N1165 G1590 A232V G1590 A232V Q238H G1590 A232V Q238H | G155D A232V 0235H 0246R G155D A232V 0236H 0246R G155D A232V 0236H 0246R V104I G155D A232V 0236H N116S G155D A232V 0236H G155D A232V 0236H 0246R | G155D AZ3ZV Q239H Q246R N0246D G155D AZ3ZV Q239H Q245R N0246D G155D AZ3ZV Q239H Q245R N0246D N168 G155D AZ3ZV Q236H Q245R N168 G155D AZ3ZV Q236H Q245R G155D AZ3ZV Q236H Q245R N246D G155D AZ3ZV Q236H Q246R N246D | G1560 | G165D A232V Q239H Q246R N246D N252K T260R G155D A232V Q239H Q246R N246D N551K Q257R G159D A232V Q239H Q245R N246D N551K Q259D N161K G159D A232V Q239H Q245R N246D N551K N261K N251K G159D A222V Q239H Q245R N246D N551K N251K | G156D A232V Q239H Q246R N246D N252K T269R G159D A232V Q239H Q246R N246D N553K Z558D V104I G159D A232V Q239H Q245R N248D N252K G259D N168 G159D A232V Q239H Q245R N246D N252K N252K G159D A232V Q239H Q245R N246D N252K N251K N251K G159D A232V Q239H Q245R N249D N252K N251K N251K G159D A232V Q239H Q245R N249D N252K N251K N |

| V68A | M76D | S103A | V1041 | G159D | A232V | Q236H | Q236H Q245R | N248D | N252K | | |
|-------|-------|--------|-------|-------|-------|--------|-------------|-------------------|---|-------|-------|
| V68A | S103A | V1048 | A232V | Q236H | Q245R | N248D | N252K | | | | |
| S103A | V104i | G159D | A232S | Q236H | 0245R | N248D | N252K | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236R | Q245R | N248D | NZ52K | | | |
| N18S | V63A | S103A | V1048 | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104 | G159D | A232V | 0236Н | 0245V | N248D | N252K | *************************************** | | |
| VEBA | N76D | S101T | S103A | V104I | G159D | T213R | N218S | A232V | Q236H | 0245R | T260A |
| V68A | S103A | V104f | G159D | A228V | A232V | Q236H | Q245R | N248D | N252K | | |
| T33S | V68A | N76D | S103A | V104 | G159D | A232V | О236Н | 0245R | N248D | N252K | |
| V68A | M76D | E89D | S103A | V104 | G159D | P2101. | T213R | A232V | Q236H | Q245R | T260A |
| GB1E | V68A | N76D | S103A | V1048 | G159D | A232V | Q236H | Q245R | N248D | N252K | |
| S103A | V104I | G159D | V205I | P210 | A232V | Q236H | O245R | | | | |
| G61E | V68A | S103A | V1048 | S130A | G159D | A232V | Q236H | Q245R | N248D | N252K | |
| GRIE | V68A | S103A | V104l | A133S | Q137R | G159D | A232V | Q236H | Q245R | N248D | N252K |
| G81E | S103A | V104! | A133V | G159D | A232V | O236H | Q245R | N248D | N252K | | |
| V68A | S103A | V104E | G159D | A232V | Q236H | 0245R | N248G | N252K | *************************************** | | |
| V68A | S103A | V1048 | G159D | N218S | A232V | Q236H | Q245R | N248D | N252K | | |
| G81E | V68A | \$1034 | V1848 | G159D | S160V | A232V | Q236H | Q245R | N248D | N252K | |
| S3 | G51E | V68A | N76D | S103A | V104 | A232V | Q236H | A232V Q236H Q245R | N248D | N252K | |

| | G159C G159C G159C | | G159D A232V A232V | | | A232V 0236H 0245R 0245R N248D N252K 0245R N248D N252K 0245R N248D N252K | N252K N252K N252K | N248D | N2552K |
|---|-------------------------|------|-------------------------|----------------|--|--|---------------------------------------|----------------|--------|
| V1041 G159D V1041 G159D V1041 G159D | G158 G158 G158 | | A232V | Q236H Q236H | 0245R 0245R | N248D N248D N248D | N252K N252K | | |
| + | G159 | 00 | A232V A232V | O236H O236H | 0245R 0245R | | N252K N252K | | |
| G159D A232V G109R G159D | A232) G159 | 5.0 | Q236H A232V | | Q245R N248D N252K N261R Q236H Q245R N248D N252K | N252K N248D | N281R N252K | | |
| V1041 G159D G159D N184D | G159 N184 | 0 0 | A232V A232V | Q236H | Q245R Q245R | N248D N248D | N252K N252K | | |
| G159D S166D G159D L217E | S1660 | 0 20 | A232V A232V | Q236H | Q245R Q245R | N248D N248D | N252K N252K | | |
| \$103A V104i | V104i | | G159D T213R | T213R A232V | A232V G236H | Q245R | Q245R N248D | NZ48D NZ52K | N252K |
| G159D Q206R | Q206F | 1 | L217E | A232V | Q236H | Q245R | N248D | N252K | |
| V1041 G159D | G159D | | G159D 0206R | | Q236H | Q245R | A232V Q236H Q245R N248D N252K | N252K | |

| S103A | V104 | S130G | G159D | A232V | Q236H | Q245R | N248D | N252K | | | - | |
|-------|-------|-------|-------|---------------|--------|-------------|---------------|-------|---|-------|---|---|
| S103A | V1041 | P131V | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| K27N | S103A | V1048 | G159D | A232V | Q236H | Q245R | N248D | N252K | | | | |
| T38G | S103A | V104f | G159D | A232V | O236H | Q245R | N248D | N252K | | | | |
| T38A | N76D | S103A | V104E | G159D | T213R | A232V | C236H | Q245R | T260A | | | |
| V68A | N76D | S103A | V1048 | G159D | T2 13R | A232V | Q238H | Q245R | T260A | E271G | | |
| V68A | N76D | S103A | 71041 | G159D | Y209W | T213R | A232V | О236Н | Q245R | T260A | | |
| V68A | U9/N | S103A | V1041 | G159D | P210I | T213R | A232V | Q236H | Q245R | T260A | | |
| V68A | N76D | S103A | V104! | G159D | V205I | T213R | T213R A232V | Q236H | Q245R | T260A | | |
| V68A | N76D | S103A | V1041 | G159D | P210I | A232V | C236H | Q245R | T260A | | | |
| V68A | S103A | V104 | G159D | T213R | A232V | Q236H Q245R | Q245R | T260A | | | | |
| 09/N | S103A | V1048 | G159D | T213R | A232V | Q236H Q245R | Q245R | T260A | | | | |
| V68A | S103A | 71041 | G159D | Y209W | A232V | Q236H | 0245R | | | | | |
| V68A | S103A | V104I | G159D | P210f | A232V | Q236H | Q245R | | | | | |
| VEBA | S103A | V104 | G159D | A230V | A232V | Q236H | Q245R | | | | - | |
| V68A | S103A | V104! | G159D | L126F | A232V | O236H | O245R | | *************************************** | | | |
| V68A | S103A | V104! | G159D | V205I | A232V | Q236H | 0245R | | | | | *************************************** |
| V68A | S103A | V104) | G169D | P210L | A232V | Q238H | Q245R | | *************************************** | | | |
| S103A | V1048 | G159D | A230V | Q236H Q245R | Q245R | | | | | | | ******* |

| V58A | S103A | V104 | G159D | A232V | Q236H | Q245R | TZ60A | | | | 7 |
|-------|-------|-------|-------|-------|--------|-------------------------------|-------|--------|-------|-------|---|
| S103A | V104I | G159D | A232V | Q236H | Q245R | | | | | | |
| V68A | S103A | V1041 | G159D | A174V | A232V | Q236H | Q245R | L257V | | | |
| V68A | S103A | V1048 | G159D | A1945 | A232V | Q236H | Q245R | 1.2577 | | | |
| V68A | S103A | V1041 | G159D | Y209W | A232V | Q236H | Q245R | 12577 | | | |
| S103A | V104 | G459D | A232V | Q236H | Q245R | 1.257V | | | | | |
| V68A | N76D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | T260A | NZ61W | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | NZ61W | | | |
| S103A | V104 | G159D | T213R | A232V | Q236H | Q245R | T260A | | | | |
| S103A | V104i | G159D | P210I | A232V | Q236H | Q245R | N248D | N252K | | | |
| S103A | V104! | G159D | Y209W | A232V | Q236H | G236H G245R | L257V | | | | |
| V68A | N76D | S103A | V104I | G159D | P210L | T213R | A232V | Q236H | Q245R | T260A | |
| Q12R | S103A | V1048 | G159D | Y209W | T213R | A232V | Q238H | Q245R | T260A | | |
| S103A | V104 | Y209W | A232V | Q236H | Q245R | L257V | | | | | |
| S103A | V104i | G159D | V205i | P210I | T213R | A232V | Q236H | 0245R | T260A | | *************************************** |
| S103A | V104 | G159D | V205f | Y209W | A232V | 0236Н | Q245R | T260A | | | |
| V68A | S103A | V104I | G159D | V206! | Y209/W | P210 | A232V | Q236H | O245R | | |
| S103A | V104 | G159D | V205I | Y209W | P2101 | A232V. | O236H | Q245R | 1257V | | |
| S103A | 7104 | G159D | V205! | YZOBW | | A232V Q236H Q245R L257V | Q245R | (257 | | | |

| V68A | S103A | V.102. | G159D | V2051 | Y209W | P210 | A232V | Q236H | Q245R | 1280A | | |
|--------|-------|--------|-------|-------------|--------|-------|-------------|-------|-------|-------|---|---|
| S103A | V1041 | G159D | V2058 | Y209W | P2108 | A232V | Q236H | Q245R | | | | |
| S103A | V1048 | G159D | Y209W | P2101 | A232V | C236H | Q245R | | | | - | - |
| S103A | V1048 | G159D | V2058 | 2.0 | A232V | 0238H | O245R | | | | i | *************************************** |
| V68A | S103A | V1041 | S128L | G159D | A232V | О236Н | Q245R | | | | | *************************************** |
| A48V | STOSA | V104I | G159D | A230V | Q236H | Q245R | | | | | | |
| A48V | V68A | S103A | V104I | G159D | Y209W | A232V | Q236H | O245R | | | | |
| A48V | V68A | S103A | V104 | G159D | A232V | Q236H | Q245R | N248D | N252K | - | | |
| A48V | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | L257V | W261W | | | An species agreement |
| G102A | S103A | V104! | G159D | \$2126 | A232V | Ф236Н | Q245R | N248D | N252K | | | *************************************** |
| O12R | G102A | S103A | V1048 | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | G102A | S103A | V104 | G159D | \$212G | A232V | Q236H | Q245R | N248D | N252K | | *************************************** |
| AGBL | G102A | S103A | V104! | G159D | \$2126 | A232V | Q236H | 0245R | N248D | N252K | | |
| G102A | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | | | |
| S103A | V1041 | P131V | G159D | A232V | О236Н | Q245R | Q245R N248D | M252K | | | | |
| S103A | V104 | G159D | N164S | A232V | Q236H | Q245R | N248D | M252K | | | | *************************************** |
| \$103A | V104! | G159D | N184G | A232V | O236H | Q245R | N248D | N252K | | | | |
| S103A | V104I | G159D | A232V | О236Н | V244T | Q245R | N248D | NZ52K | | | | *************************************** |
| S103A | | G159D | A232V | Q236H V244A | | Q245R | Q245R N248D | N252K | | | | |

| NezD | S103A | V104! | G159D | T213R | A232V | A232V 0236H | O245R N248D | N248D | N252K | S256R | |
|-------|-------|--------|--------|-------|--------|-------------|--|-------|---|----------|---|
| Q12R | N62D | S103A | V104I | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | |
| S101G | S103A | V104! | G159D | N185D | A232V | Q236H | Q245R | N248D | N252K | | |
| S101G | S103A | V1048 | G159D | Q206E | A232V | Q236H | O245R | N248D | N252K | | |
| S101G | S103A | V1046 | G159D | T213Q | A232V | Q236H | G245R | N248D | N252K | | |
| A98L | G102A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | M252K | | *************************************** |
| S101G | G102A | S103A | V104! | G159D | A232V | Q236H | Q245R | N248D | N262K | | |
| A98L | G102A | S103A | V1041 | G159D | S212G | A232V | Q236H | Q245R | N248D | N252K | |
| A981. | G102A | S103A | V1041 | G159D | \$2126 | A232V | Q236H | N248D | N252K | | |
| N62D | S103A | V1048 | Q109R | G159D | 72.13R | A232V | G236H | Q245R | N248D | N252K | |
| N62D | S103A | V1048 | G159D | S212G | T213R | A232V | Q236H | Q245R | N248D | N252K | |
| N62D | S101G | \$103A | V104! | G159D | S212G | T213R | A232V | Q236H | Q245R | N248D | N252K |
| S103A | V104 | G159D | A232V | Q245R | N248D | N252K | | | *************************************** | | |
| S103A | V1041 | G159D | A230V | Q245R | | | | | | | |
| NB2D | S103A | V104I | S130G | G159D | T213R | A232V | Q236H | Q245R | N248D | N252K | ******* |
| S101G | S103A | V104I | S130G | G159D | A232V | C236H | O245R | N248D | N252K | | *************************************** |
| S101G | S103A | V104I | \$128G | G159D | A232V | Q236H | Q245R | N248D | N252K | | *************************************** |
| S101G | S103A | V104I | S128L | G159D | A232V | Q236H | Q245R | N248D | N252K | | |
| NG2D | 54030 | 64000 | 156040 | 0.000 | marana | 42000 | Cascia Constitution of the | 00700 | Stoken | Series a | |

| | | *** | | | | | | | | | |
|---------------------------|---------------|--------|---|-------|-----------------------|-------------------|-------|-------|---|---|---|
| V1041 S128G G159D T | S128G G159D | mi | - | 1213R | A232V Q236H Q245R | Q236H | | N248D | N252K | | |
| V1041 S1281 G159D T | S128L G159D | | - | T213R | A232V | Q236H | 0245R | N248D | N252K | | |
| V1041 G159D A232V C | G169D A232V | | 0 | Q236H | Q245R | N248D | N252K | T260A | 1 | *************************************** | *************************************** |
| V104 P131V G159D | P131V | G159D | | A232V | Q236H Q245R | Q245R | N248D | N252K | | ************* | *************************************** |
| S103A V104[G159D | V104[| G159D | | A232V | Q236H | O245R | N248D | N252K | | - | |
| S103A V104 G159D | V104! | G159D | | A232V | O236H Q245R | Q245R | N248D | N252K | 100000000000000000000000000000000000000 | | |
| V1041 G159D S212G | G159D | \$2126 | | A232V | Q236H | O245R | N248D | N252K | | | re- incode de d |
| V104I G159D Y209W | G159D | YZOGW | | A232V | Q236H Q245R | Q245R | N248D | N252K | | Aggreen and a second | * The Part of the Contract of |
| V104[G159D P210] | G159D | P210 | | A232V | G236H | Q245R | N248D | N252K | *************************************** | | |
| V104[G159D V205] | G159D | V205I | | A232V | Q236H Q245R | Q245R | N248D | N252K | | ************* | *************************************** |
| V1041 G159D A230V | G159D | A230V | | Q238H | Q246R | | | | | | |
| V1041 G159D A194P | G159D | A194P | | A232V | O235H Q245R | | N248D | N252K | | | *************************************** |
| S103A V104 G159D | V104i | G159D | | A194P | A232V | Q236H | Q245R | N248D | NZSZK | ****************** | - |
| V104I G159D A230V | G159D | A230V | | A232V | Q236H | G236H G245R N248D | N248D | N252K | | | Name and State of the |
| V104F G159D N185D G206E | 01800 | | | - | | | 1 | | 4000 | Amendo | OLICA ROSES FOLIO |

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It is a further object to provide DNA sequences encoding such protease variants, as well as expression vectors containing such variant DNA sequences.

Still further, another object of the invention is to provide host cells transformed with such vectors, as well as host cells which are capable of expressing such DNA to produce protease variants either intracellularly or extracellularly.

There is further provided a cleaning composition comprising a protease variant of the present invention

Additionally, there is provided an animal feed comprising a protease variant of the present invention.

Also provided is a composition for the treatment of a textile comprising a protease variant of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

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Figs. 1 A-C depict the DNA and amino acid sequence for *Bacillus* amyloliquefaciens subtilisin and a partial restriction map of this gene.

Fig. 2 depicts the conserved amino acid residues among subtilisins from Bacillus amyloliquefacions (BPN)' and Bacillus lentus (wild-type).

Figs. 3A and 3B depict the amino acid sequence of four subtilisins. The top line represents the amino acid sequence of subtilisin from Bacillus arrayloliquefacions subtilisin (also sometimes referred to as subtilisin BPN*). The second line depicts the amino acid sequence of subtilisin from Bacillus subtilis. The third line depicts the amino acid sequence of subtilisin from Bacillus labelitus. The fourth line depicts the amino acid sequence of subtilisin from Bacillus lentus (also referred to as subtilisin 309 in PCT W089/06276). The symbol * denotes the absence of specific amino acid residues as compared to subtilisin BPN*.

Detailed Description of the Invention

Proteases are carbonyl hydrolases which generally act to cleave poptide bonds of proteins or peptides. As used herein, "protease" means a naturally-occurring protease or a recombinant protease. Naturally-occurring proteases include α-aminoacy/peptide hydrolase, peptidylamino acid hydrolase, acylamino hydrolase, serine carboxypeptidase, metallocarboxypeptidase, thiol proteinase, carboxylproteinase and metallocroteinase. Serine, metallo, thiol and acid proteases are included, as well as endo and exo-proteases.

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The present invention includes protease enzymes which are non-naturally occurring carbonyl hydrolase variants (protease variants) having a different proteolytic activity, stability, substrate specificity, pH profile and/or performance characteristic as compared to the precursor carbonyl hydrolase from which the amino acid sequence of the variant is derived. Specifically, such protease variants have an amino acid sequence not found in nature, which is derived by substitution of a plurality of amino acid residues of a precursor protease with different amino acids. The precursor protease may be a naturally-occurring protease or a recombinant protease.

The protease variants useful herein encompass the substitution of any of the nineteen naturally occurring L-amino acids at the designated amino acid residue positions. Such substitutions can be made in any precursor subtilisin (procaryotic, eucaryotic, mammalian, etc.). Throughout this application reference is made to vanous amino acids by way of common one - and three-letter codes. Such codes are identified in Dale, M.W. (1989), <u>Molecular Genetics of Bacteria</u>. John Wiley & Sons, Ltd., Appendix B.

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The protease variants useful herein are preferably derived from a Bacillus subtilisin. More preferably, the protease variants are derived from Bacillus lentus subtilisin and/or subtilisin 309.

Subtilisins are bacterial or fungal proteases which generally act to cleave peptide bonds of proteins or peptides. As used herein, "subtilisin" means a naturally-occurring subtilisin or a recombinant subtilisin. A series of naturally-occurring subtilisins is known to be produced and often secreted by various microbial species. Armin acid sequences of the members of this series are not entirely homologous. However, the subtilisins in this series exhibit the same or similar type of proteolytic activity. This class of serine proteases shares a common amino acid sequence detailing a catalytic triad which distinguishes them from the chymotrypsin related class of serine proteases. The subtilisins and chymotrypsin related serine proteases both have a catalytic triad comprising aspartate, histidine and serine. In the subtilisin related proteases the relative order of these amino acids, reading from the amino to carboxy terminus, is aspartate-histidine-serine. In the chymotrypsin related proteases, the relative order, however, is histidine-aspartate-serine. Thus, subtilisin herein refers to a serine protease having the catalytic triad of subtilisin related

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proteases. Examples include but are not limited to the subtilisins identified in Fig. 3 herein. Generally and for purposes of the present invention, numbering of the amino acids in proteases corresponds to the numbers assigned to the mature Bacillus amyloliquefaciens subtilisin sequence presented in Fig. 1.

"Recombinant subtilisin" or "recombinant protease" refer to a subtilisin or protease in which the DNA sequence encoding the subtilisin or protease is modified to produce a variant (or mutant) DNA sequence which encodes the substitution, deletion or insertion of one or more amino acids in the naturally-occurring amino acid sequence. Suitable methods to produce such modification, and which may be combined with those disclosed herein, include those disclosed in US Patent RE 34.606, US Patent 5.204.015 and US Patent 5.163.257.

Patent 5.801.038, and U.S. Patent 5.763.257.

"Non-human subtilisins" and the DNA encoding them may be obtained from many procaryotic and eucaryotic organisms. Suitable examples of procaryotic organisms include gram negative organisms such as *E. coli* or *Pseudomonas* and gram positive bacteria such as *Micrococcus* or *Bacillus*. Examples of eucaryotic organisms from which subtilisin and their genes may be obtained include yeast such as *Saccharomyces cerevisiae*, fungi such as *Aspergiilus* sp.

A "protease variant" has an amino acid sequence which is derived from the amino acid sequence of a "precursor proteases". The precursor proteases include naturally-occurring proteases and recombinant proteases. The amino acid sequence of the protease variant is "derived" from the precursor protease amino acid sequence by the substitution, deletion or insertion of one or more amino acids of the precursor amino acid sequence. Such modification is of the "precursor DNA sequence" which encodes the amino acid sequence of the precursor protease rather than manipulation of the precursor DNA sequence include methods disclosed herein, as well as methods known to those skilled in the art (see, for example, EP 0 328299, WO69/06279 and the US patents and applications already referenced herein).

Specific substitutions of amino acids at one or more residue positions corresponding to residue positions selected from the group consisting of 62, 212, 230, 232, 252 and 257 of Bacillus amyloliquefaciens subtilisin are identified herein.

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Preferred variants are those having combinations of substitutions at residue positions corresponding to positions of *Bacillus amyloliquefaciens* subtilisin in Table 1.

More preferred variants are those having combinations of substitutions at residue positions corresponding to positions of Bacillus amyloliquefaciens subtilisin in Table 2.

Further preferred variants are those having combinations of substitutions at residue positions corresponding to positions of *Bacillus amyloliquefaciens* subtilisin in Table 3.

Table 3

| | 250 | | | | | | | | | | | 245 | | | 259 | 280 |
|-----|-----|-----|-----|-----|-----|-----|---|-----|-----|-----|-----|-----|-----|-----|-----|-------|
| | 245 | 252 | | 252 | 252 | | *************************************** | 245 | 257 | - | 245 | 236 | 245 | 245 | 245 | 345 |
| 252 | 236 | 248 | İ | 245 | 245 | 245 | 257 | 236 | 245 | 257 | 236 | 232 | 236 | 236 | 236 | 296 |
| 245 | 232 | 245 | 245 | 236 | 236 | 236 | 245 | 232 | 236 | 245 | 232 | 214 | 232 | 232 | 232 | 233 |
| 236 | 213 | 236 | 236 | 232 | 232 | 232 | 236 | 210 | 232 | 236 | 211 | 159 | 215 | 159 | 159 | 150 |
| 232 | 159 | 232 | 232 | 159 | 159 | 159 | 232 | 159 | 224 | 232 | 159 | 20 | 159 | 104 | 104 | 104 |
| 159 | 104 | 159 | 159 | 140 | 104 | 104 | 159 | 104 | 159 | 159 | 104 | 103 | 104 | 103 | 103 | 183 |
| ģ | 103 | 104 | 104 | 107 | 103 | 103 | 104 | 103 | 104 | 40 | 103 | 7.6 | 103 | 76 | 76 | 27 |
| 103 | 76 | 103 | 103 | 103 | 68 | 88 | 103 | 76 | 103 | 103 | 76 | 89 | 7.6 | 88 | 88 | 78 |
| 68 | 88 | 68 | 68 | 68 | 43 | 43 | 88 | 88 | 88 | 76 | 68 | 12 | 68 | Č. | 8 | 82.00 |

| | | | | | | | | | | | - | <u> </u> | | | - | | - |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|-----|-----|-----|-----|-----|
| | ļ | | | | | | | | | | | 1 | | | | | - |
| | 245 | | 251 | 272 | 245 | | | | 252 | | 252 | 252 | 252 | 252 | 252 | 252 | 252 |
| 261 | 236 | | 248 | 245 | 236 | 256 | 245 | 245 | 248 | | 248 | 248 | 248 | 248 | 248 | 248 | 248 |
| 245 | 232 | 245 | 245 | 236 | 232 | 245 | 236 | 236 | 245 | 252 | 245 | 245 | 245 | 245 | 245 | 245 | 245 |
| 236 | 159 | 236 | 236 | 232 | 206 | 236 | 232 | 232 | 236 | 248 | 236 | 236 | 236 | 236 | 236 | 236 | 236 |
| 232 | 104 | 232 | 232 | 159 | 183 | 232 | 206 | 159 | 232 | 245 | 232 | 232 | 232 | 232 | 232 | 232 | 232 |
| 128 | 103 | 192 | 159 | 104 | 159 | 159 | 159 | 104 | 212 | 236 | 209 | 159 | 159 | 508 | 210 | 212 | 213 |
| 104 | 7.6 | 159 | 147 | 103 | 104 | 104 | 104 | 103 | 159 | 232 | 159 | 109 | 104 | 159 | 159 | 159 | 159 |
| 8 | 99 | 104 | \$ | 76 | 103 | 103 | 103 | 9/ | 104 | 159 | 20 | Ş | 183 | 20 | 9 | 104 | 10 |
| 76 | 48 | 103 | 103 | 68 | 76 | 76 | 76 | 68 | 103 | 104 | 103 | 103 | 68 | 103 | 103 | 103 | 103 |
| 88 | 12 | 92 | 92 | 12 | 88 | 88 | 88 | 22 | 88 | 103 | 88 | 88 | 20 | 88 | 89 | 68 | 89 |

| | , | , | , | | | | | , | , |
|-----|----------|-----|------|-----|-----|-----|-----|-----|-----|
| | | | | | | | | | |
| | | | | | | | | 260 | |
| | | | | | | | | 245 | |
| | 252 | 252 | 252 | 255 | 256 | 260 | 252 | 236 | 252 |
| 252 | 248 | 248 | 248 | 252 | 252 | 252 | 248 | 232 | 248 |
| 248 | 245 | 245 | 245 | 248 | 248 | 248 | 245 | 213 | 245 |
| 245 | 236 | 236 | 236 | 245 | 245 | 245 | 236 | 210 | 236 |
| 236 | 232 | 232 | 232 | 236 | 236 | 236 | 232 | 159 | 232 |
| 232 | 215 | 216 | 159 | 232 | 232 | 232 | 228 | 5 | 218 |
| 213 | 159 | 159 | 104 | 159 | 159 | 159 | 159 | 103 | 159 |
| 104 | \$ | 104 | 103 | 20 | 20 | 2 | 20 | 88 | 104 |
| 103 | 103 | 103 | සියි | 103 | 103 | 103 | 103 | 76 | 103 |
| 88 | 88 | 89 | 20 | 88 | 88 | 88 | 89 | 88 | 68 |
| | | | | | | | | | |

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These amino acid position numbers refer to those assigned to the mature Bacillus amyloliquefaciens subtilisin sequence presented in Fig. 1. The invention, however, is not limited to the mutation of this particular subtilisin but extends to precursor proteases containing amino acid residues at positions which are "equivalent" to the particular identified residues in Bacillus amyloliquefaciens subtilisin. In a preferred embodiment of the present invention, the precursor protease is Bacillus tentus subtilisin and the substitutions are made at the equivalent amino acid residue positions in B. ientus corresponding to those listed above.

A residue (amino acid) position of a precursor protease is equivalent to a residue of Bacillus amyloliquefaciens subtilisin if it is either homologous (i.e., corresponding in position in either primary or tentiary structure) or analogous to a specific residue or portion of that residue in Bacillus amyloliquefaciens subtilisin (i.e., having the same or similar functional capacity to combine, react, or interact chemically).

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in order to establish homology to primary structure, the amino acid sequence of a precursor protease is directly compared to the Bacillus amyloliquefaciens subtilisin primary sequence and particularly to a set of residues known to be invariant in subtilisins for which sequence is known. For example, Fig. 2 herein shows the conserved residues as between B. amyloliquefaciens subtilisin and B. lentus subtilisin. After aligning the conserved residues, allowing for necessary insertions and deletions in order to maintain alignment (i.e., avoiding the elimination of conserved residues through arbitrary deletion and insertion), the residues equivalent to particular amino acids in the primary sequence of Bacillus amyloliquefaciens subtilisin are defined. Alignment of conserved residues preferably should conserve 100% of such residues. However, alignment of greater than 75% or as little as 50% of conserved residues is also adequate to define equivalent residues. Conservation of the catalytic triad. Asp32/His64/Ser221 should be maintained. Siezen et al. (1991) Protein Eng. 4(7):719-737 shows the alignment of a large number of serine proteases. Siezen et al. refer to the grouping as subtilases or subtilisin-like serine proteases.

For example, in Fig. 3, the amino acid sequence of subtilisin from Bacillus amyloliquefaciens, Bacillus subtilis, Bacillus licheniformis (carlsbergensis) and Bacillus lentus are aligned to provide the maximum amount of homology between amino acid sequences. A comparison of these sequences shows that there are a 30

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number of conserved residues contained in each sequence. These conserved residues (as between BPN' and B. lentus) are identified in Fig. 2.

These conserved residues, thus, may be used to define the corresponding equivalent amino acid residues of Bacillus amytoliquefaciens subtilisin in other subtilisins such as subtilisin from Bacillus Ientus (PCT Publication No. W089/06279 published July 13, 1989), the preferred protease precursor enzyme herein, or the subtilisin referred to as PB92 (EP 0 328 299), which is highly homologous to the preferred Bacillus lentus subtilisin. The amino acid sequences of certain of these subtilisins are aligned in Figs. 3A and 3B with the sequence of Bacillus amyloliquefaciens subtilisin to produce the maximum homology of conserved residues. As can be seen, there are a number of deletions in the sequence of Bacillus lentus as compared to Bacillus amvioliquefaciens subtilisin. Thus, for example, the equivalent amino acid for Vat165 in Bacillus amyloliquefaciens subtilisin in the other subtilisins is isoleucine for B. lentus and B. licheniformis.

"Equivalent residues" may also be defined by determining homology at the level of tertiary structure for a precursor protease whose tertiary structure has been determined by x-ray crystallography. Equivalent residues are defined as those for which the atomic coordinates of two or more of the main chain atoms of a particular amino acid residue of the precursor protease and Bacillus amyloliquefacions subtilisin (N on N. CA on CA, C on C and O on O) are within 0.13nm and preferably 0.1nm after alignment. Alignment is achieved after the best model has been oriented and positioned to give the maximum overlap of atomic coordinates of nonhydrogen protein atoms of the protease in question to the Bacillus amyloliquefaciens subtilisin. The best model is the crystallographic model giving the lowest R factor for experimental diffraction data at the highest resolution available.

$$R factor = \frac{\sum_{h} |Fo(h)| - |Fc(h)|}{\sum_{h} |Fo(h)|}$$

Equivalent residues which are functionally analogous to a specific residue of Bacillus amvioliquefaciens subtilisin are defined as those amino acids of the precursor protease which may adopt a conformation such that they either aiter. modify or contribute to protein structure, substrate binding or catalysis in a manner

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defined and attributed to a specific residue of the *Bacillus amyloliquefaciens* subtilisin. Further, they are those residues of the precursor protease (for which a tertiary structure has been obtained by x-ray crystallography) which occupy an analogous position to the extent that, although the main chain atoms of the given residue may not satisfy the criteria of equivalence on the basis of occupying a homologous position, the atomic coordinates of at least two of the side chain atoms of the residue lie with 0.13mm of the corresponding side chain atoms of the residue lie with 0.13mm of the coordinates of the three dimensional structure of *Bacillus amyloliquefaciens* subtilisin. The coordinates of the three dimensional structure of *Bacillus amyloliquefaciens* subtilisin are set forth in EPO Publication No. 0 251 448 (equivalent to US Patent 5.182,204, the disclosure of which is incorporated herein by reference) and can be used as outlined above to determine equivalent residues on the level of tertiary structure.

Some of the residues identified for substitution are conserved residues whereas others are not. In the case of residues which are not conserved, the substitution of one or more amino acids is limited to substitutions which produce a variant which has an amino acid sequence that does not correspond to one found in nature. In the case of conserved residues, such substitutions should not result in a naturally-occurring sequence. The protease variants of the present invention include the mature forms of protease variants, as well as the pro- and prepro-forms of such protease variants. The prepro-forms are the preferred construction since this facilitates the excression, secretion and maturation of the protease variants.

"Prosequence" refers to a sequence of amino acids bound to the N-terminal portion of the mature form of a protease which when removed results in the appearance of the "mature" form of the protease. Many proteolytic enzymes are found in nature as translational proenzyme products and, in the absence of post-translational processing, are expressed in this fashion. A preferred prosequence for producing protease variants is the putative prosequence of Bacillus amyloliquefaciens subtilisin, although other protease prosequences may be used.

A "signal sequence" or "presequence" refers to any sequence of amino acids bound to the N-terminal portion of a protease or to the N-terminal portion of a proprotease which may participate in the secretion of the mature or pro forms of the protease. This definition of signal sequence is a functional one, meant to include all those amino acid sequences encoded by the N-terminal portion of the protease gene which participate in the effectuation of the secretion of protease under native

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conditions. The present invention utilizes such sequences to effect the secretion of the protease variants as defined herein. One possible signal sequence comprises the first seven amino acid residues of the signal sequence from *Bacillus subtilis* subtilisin fused to the remainder of the signal sequence of the subtilisin from *Bacillus lentus* (ATCC 21536).

A "prepro" form of a protease variant consists of the mature form of the protease having a prosequence operably linked to the amino terminus of the protease and a "pre" or "signal" sequence operably linked to the amino terminus of the prosequence.

"Expression vector" refers to a DNA construct containing a DNA sequence which is operably linked to a suitable control sequence capable of effecting the expression of said DNA in a suitable host. Such control sequences include a promoter to effect transcription, an optional operator sequence to control such transcription, a sequence encoding suitable mRNA ribosome binding sites and sequences which control termination of transcription and translation. The vector may be a plasmid, a phage particle, or simply a potential genomic insert. Once transformed into a suitable host, the vector may replicate and function independently of the host genome, or may, in some instances, integrate into the genome itself. In the present specification, "plasmid" and "vector" are sometimes used interchangeably as the plasmid is the most commonly used form of vector at present. However, the invention is intended to include such other forms of expression vectors which serve equivalent functions and which are, or become, known in the art.

The "host cells" used in the present invention generally are procaryotic or eucaryotic hosts which preferably have been manipulated by the methods disclosed in US Patent RE 34,606 to render them incapable of secreting enzymatically active endoprolease. A preferred host cell for expressing protease is the Bacillus strain BG2036 which is deficient in enzymatically active neutral protease and alkaline protease (subtilisin). The construction of strain BG2036 is described in detail in US Patent 5,264,365. Other host cells for expressing protease include Bacillus subtilis 1168 (also described in US Patent RE 34,606 and US Patent 5,264,365, the disciosure of which are incorporated herein by reference), as well as any suitable Bacillus strain such as B. licheniformis, B. lentus, etc.

Host cells are transformed or transfected with vectors constructed using recombinant DNA techniques. Such transformed host cells are capable of either WO 99/20769 PCT/US98/22500

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replicating vectors encoding the protease variants or expressing the desired protease variant. In the case of vectors which encode the pre- or prepro-form of the protease variant, such variants, when expressed, are typically secreted from the host cell into the host cell medium.

"Operably linked," when describing the relationship between two DNA regions, simply means that they are functionally related to each other. For example, a presequence is operably linked to a peptide if it functions as a signal sequence, participating in the secretion of the mature form of the protein most probably involving cleavage of the signal sequence. A promoter is operably linked to a coding sequence if it controls the transcription of the sequence; a ribosome binding site is operably linked to a coding sequence if it is positioned so as to permit translation.

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The genes encoding the naturally-occurring precursor protease may be obtained in accord with the general methods known to those skilled in the art. The methods generally comprise synthesizing labeled probes having putative sequences encoding regions of the protease of interest, preparing genomic libraries from organisms expressing the protease, and screening the libraries for the gene of interest by hybridization to the probes. Positively hybridizing clones are then mapped and sequenced.

The cloned protease is then used to transform a host cell in order to express the protease. The protease gene is then ligated into a high copy number plasmid. 20 This plasmid replicates in hosts in the sense that it contains the well-known elements necessary for plasmid replication; a promoter operably linked to the gene in question (which may be supplied as the gene's own homologous promoter if it is recognized, i.e., transcribed, by the host), a transcription termination and 25 polyadenylation region (necessary for stability of the mRNA transcribed by the host from the protease gene in certain eucaryotic host cells) which is exogenous or is supplied by the endogenous terminator region of the protease gene and, desirably, a selection gene such as an antibiotic resistance gene that enables continuous cultural maintenance of plasmid-infected host cells by growth in antibiotic-containing media. High copy number plasmids also contain an origin of replication for the host, thereby 30 enabling large numbers of plasmids to be generated in the cytoplasm without chromosomal limitations. However, it is within the scope herein to integrate multiple copies of the protease gene into host genome. This is facilitated by procaryotic and

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eucaryotic organisms which are particularly susceptible to homologous recombination.

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The gene can be a natural *B. lentus* gene. Alternatively, a synthetic gene encoding a naturally-occurring or mutant precursor protease may be produced. In such an approach, the DNA and/or amino acid sequence of the precursor protease is determined. Multiple, overlapping synthetic single-stranded DNA fragments are thereafter synthesized, which upon hybridization and ligation produce a synthetic DNA encoding the precursor protease. An example of synthetic gene construction is set forth in Example 3 of US Patent 5,204,015, the disclosure of which is incorporated herein by reference.

Once the naturally-occurring or synthetic precursor protease gene has been cloned, a number of modifications are undertaken to enhance the use of the gene beyond synthesis of the naturally-occurring precursor protease. Such modifications include the production of recombinant proteases as disclosed in US Patent RE 34,606 and EPO Publication No. 0 251 446 and the production of protease variants described berein.

The following cassette mutagenesis method may be used to facilitate the construction of the protease variants of the present invention, although other methods may be used. First, the naturally-occurring gene encoding the protease is obtained and sequenced in whole or in part. Then the sequence is scanned for a point at which it is desired to make a mutation (deletion, insertion or substitution) of one or more amino acids in the encoded enzyme. The sequences flanking this point are evaluated for the presence of restriction sites for replacing a short segment of the gene with an oligonucleotide pool which when expressed will encode various mutants. Such restriction sites are preferably unique sites within the protease gene so as to facilitate the replacement of the gene segment. However, any convenient restriction site which is not overly redundant in the professe gene may be used. provided the gene fragments generated by restriction digestion can be reassembled in proper sequence. If restriction sites are not present at locations within a convenient distance from the selected point (from 10 to 15 nucleotides), such sites are generated by substituting nucleotides in the gene in such a fashion that neither the reading frame nor the amino acids encoded are changed in the final construction. Mutation of the gene in order to change its sequence to conform to the desired sequence is accomplished by M13 primer extension in accord with generally known

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methods. The task of locating suitable flanking regions and evaluating the needed changes to arrive at two convenient restriction site sequences is made routine by the redundancy of the genetic code, a restriction enzyme map of the gene and the large number of different restriction enzymes. Note that if a convenient flanking restriction site is available, the above method need be used only in connection with the flanking region which does not contain a site.

Once the naturally-occurring DNA or synthetic DNA is cloned, the restriction sites flanking the positions to be mutated are digested with the cognate restriction enzymes and a plurality of end termini-complementary oligonucleotide cassettes are ligated into the gene. The mutagenesis is simplified by this method because all of the oligonucleotides can be synthesized so as to have the same restriction sites, and no synthetic linkers are necessary to create the restriction sites.

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As used herein, proteolytic activity is defined as the rate of hydrolysis of peptide bonds per milligram of active enzyme. Many well known procedures exist for measuring proteolytic activity (K. M. Kallsz, "Microbial Proteinases," <u>Advances in Biochemical Engineering/Biotechnology</u>, A. Flechter ed., 1988). In addition to or as an alternative to modified proteolytic activity, the vanante rezymes of the present invention may have other modified properties such as K_m, K_{cal}, K_{cal}/K_m ratio and/or modified substrate specificity and/or modified pH activity profile. These enzymes can be tallored for the particular substrate which is anticipated to be present, for example, in the preparation of peptides or for hydrolytic processes such as laundry uses.

In one aspect of the invention, the objective is to secure a variant protease having altered, preferably improved wash performance as compared to a precursor protease in at least one detergent formulation and or under at least one set of wash conditions.

There is a variety of wash conditions including varying detergent formulations, wash water volume, wash water temperature and length of wash time that a protease variant might be exposed to. For example, detergent formulations used in different areas have different concentrations of their relevant components present in the wash water. For example, a European detergent typically has about 4500-5000 ppm of detergent components in the wash water while a Japanese detergent (typically has approximately 667 ppm of detergent components in the wash

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water. In North America, particularly the United States, a detergent typically has about 975 ppm of detergent components present in the wash water.

A low detergent concentration system includes detergents where less than about 800 ppm of detergent components are present in the wash water. Japanese detergents are typically considered low detergent concentration system as they have approximately 667 ppm of detergent components present in the wash water.

A medium detergent concentration includes detergents where between about 800 ppm and about 2000ppm of detergent components are present in the wash water. North American detergents are generally considered to be medium detergent concentration systems as they have approximately 975 ppm of detergent components present in the wash water. Brazit typically has approximately 1500 ppm of detergent components present in the wash water.

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A high detergent concentration system includes detergents where greater than about 2000 ppm of detergent components are present in the wash water. European detergents are generally considered to be high detergent concentration systems as they have approximately 4500-5000 ppm of detergent components in the wash water.

Latin American detergents are generally high suds phosphate builder detergents and the range of detergents used in Latin America can fall in both the medium and high detergent concentrations as they range from 1500 ppm to 5000 ppm of detergent components in the wash water. As mentioned above, Brazil typically has approximately 1500 ppm of detergent components present in the wash water. However, other high suds phosphate builder detergent geographies, not limited to other Latin American countries, may have high detergent concentration systems up to about 6000 ppm of detergent components present in the wash water.

In light of the foregoing, it is evident that concentrations of detergent compositions in typical wash solutions throughout the world vanes from less than about 800 ppm of detergent composition ("low detergent concentration geographies"), for example about 667 ppm in Japan, to between about 800 ppm to about 2000 ppm ("medium detergent concentration geographies"), for example about 975 ppm in U.S. and about 1500 ppm in Brazil, to greater than about 2000 ppm ("high detergent concentration geographies"), for example about 4500 ppm to about 5000 ppm in Europe and about 6000 ppm in high suds phosphate builder geographies.

The concentrations of the typical wash solutions are determined empirically. For example, in the U.S., a typical washing machine holds a volume of about 64.4 L of wash solution. Accordingly, in order to obtain a concentration of about 975 ppm of detergent within the wash solution about 62.79 g of detergent composition must be added to the 64.4 L of wash solution. This amount is the typical amount measured into the wash water by the consumer using the measuring cup provided with the detergent.

As a further example, different geographies use different wash temperatures.

The temperature of the wash water in Japan is typically less than that used in

Accordingly one aspect of the present invention includes a protease variant that shows improved wash performance in at least one set of wash conditions.

in another aspect of the invention, it has been determined that substitution of an amino acid at one or more residue positions corresponding to residue positions selected from the group consisting of 62, 212, 230, 232, 252 and 257 of Bacillus amyloliquefaciens subtilisin are important in improving the wash performance of the enzyme.

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These substitutions are preferably made in *Bacillus lentus* (recombinant or native-type) subtilisin, although the substitutions may be made in any *Bacillus* protease.

Based on the screening results obtained with the variant proteases, the noted mutations in *Bacillus amyloliquefaciens* subtilism are important to the proteolytic activity, performance and/or stability of these enzymes and the cleaning or wash performance of such variant enzymes.

Many of the protease variants of the invention are useful in formulating various detergent compositions or personal care formulations such as shampoos or lotions. A number of known compounds are suitable surfactants useful in compositions comprising the protease mutants of the invention. These include nonionic, anionic, cationic, or zwitterionic detergents, as disclosed in US 4.404,128 to Barry J. Anderson and US 4.261,868 to Jirí Flora, et al. A suitable detergent formulation is that described in Example 7 of US Patent 5.204,015 (previously incorporated by reference). The art is familiar with the different formulations which can be used as cleaning compositions. In addition to typical cleaning compositions, it is readily understood that the protease variants of the present invention may be

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used for any purpose that native or wild-type proteases are used. Thus, these variants can be used, for example, in bar or liquid soap applications, dishcare formulations, contact lens cleaning solutions or products, peptide hydrolysis, waste treatment, textile applications, as fusion-cleavage enzymes in protein production, etc. The variants of the present invention may comprise enhanced performance in a detergent composition (as compared to the precursor). As used herein, enhanced performance in a detergent is defined as increasing cleaning of certain enzyme sensitive stains such as grass or blood, as determined by usual evaluation after a standard wash cycle.

Proteases of the invention can be formulated into known powdered and liquid detergents having pH between 6.5 and 12.0 at levels of about 0.01 to about 5% (preferably 0.1% to 0.5%) by weight. These detergent cleaning compositions can also include other enzymes such as known proteases, amylases, cellulases, lipases or endodycosidases, as well as builders and stabilizers.

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The addition of proteases of the invention to conventional cleaning compositions does not create any special use limitation. In other words, any temperature and pH suitable for the detergent is also suitable for the present compositions as long as the pH is within the above range, and the temperature is below the described protease's denaturing temperature. In addition, proteases of the invention can be used in a cleaning composition without detergents, again either along or in combination with builders and stabilizers.

The present invention also relates to cleaning compositions containing the protease variants of the invention. The cleaning compositions may additionally contain additives which are commonly used in cleaning compositions. These can be selected from, but not limited to, bleaches, surfactants, builders, enzymes and bleach catalysts. It would be readily apparent to one of ordinary skill in the art what additives are suitable for inclusion into the compositions. The list provided herein is by no means exhaustive and should be only taken as examples of suitable additives. It will also be readily apparent to one of ordinary skill in the art to only use those additives which are compatible with the enzymes and other components in the composition, for example, surfactant.

When present, the amount of additive present in the cleaning composition is from about 0.01% to about 99.9%, preferably about 1% to about 95%, more preferably about 1% to about 80%.

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The variant proteases of the present invention can be included in animal feed such as part of animal feed additives as described in, for example, US 5.612.055; US 5.314.692; and US 5.147,642.

One aspect of the invention is a composition for the treatment of a textile that includes variant proteases of the present invention. The composition can be used to treat for example silk or wool as described in publications such as RD 216.034; EP 134,267; US 4.533.359; and EP 344,259.

The following is presented by way of example and is not to be construed as a limitation to the scope of the claims.

All publications and patents referenced herein are hereby incorporated by reference in their entirety.

Example 1

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A large number of protease variants were produced and purified using

15 methods well known in the arr. All mutations were made in *Bacillus lentus* GG38 subtilisin. The variants are shown in Table 4.

Table 4

| V104 V104 N261D S160T S216C V104 V104 |
|--|
| N261D S160T S216C V104I |
| \$216C V104ii |
| V104i |
| 64004 (404) 644740 |

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|---------|-------------|---------|---------|--|--|---|--|-------|---------|---|-------|-------------|-------------|---------|---------|-------------|-----------|
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| | g | | | The second secon | | | | | | *************************************** | | Q | A 3 | | | 3.1 | |
| V104! | V104! K237Q | V104i | N183D | V1041 | V104I | V104 | N184D | N252D | S259C | K251T | V104I | V1041 N185D | K237E T274A | \$1601. | A228V | V104I S24DT | ASSAT |
| S103A \ | S103A | S103A \ | V1041 N | S103A \ | S103A \ | S103A \ | V104! N | V1048 | V1041 S | ×104 | S103A | S103A | V1041 K | V1041 S | V1041 A | S103A \ | V3021 1 A |
| N76D | N76D | N76D | S103A | N76D | N76D | U9/N | S103A | S103A | S103A | S103A | P86S | N76D | S103A | S103A | S103A | N76D | S103A |
| T38S | T38S | 187 | 09/N | R19L | A13V | R19C | N76D | 092N | Q9/N | Q9/N | 092N | 1720 | C9ZN | M76D | Q9/N | PSSS | NYKD |

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|-------|-------|----------|-------|-------|----------|-------|-------|--|--|-------|-------|-------|----------|-------------|-------|-------|-------------|
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| | | - | | | | | | and the same of th | Orange de la company de la com | | | K251R | | | | | |
| | | | | V177A | | | | | | | | Q236R | K237E | | | N204T | |
| N204T | NZ04D | V104I | G159D | V104I | V104I | A270V | N185D | V104E | L262M | V1041 | V104I | S166G | V104I | S130L | O109R | V104I | D181N |
| 104N | V104i | S103A | 7104 | S103A | S103A | V104i | V1041 | S103A | V104i | S103A | S103A | V104I | S103A | V104 | V104 | S103A | V104i |
| S103A | S103A | M76D | S103A | 092N | 092N | S103A | S103A | N76D | S103A | S78P | 09/N | S103A | 09ZN | S103A | S103A | S99R | S103A |
| Q9/N | 09/N | N43S | 09/N | R10H | T58S | N76D | 09/N | K27N | N76D | Q92N | S24P | N76D | H17L | NZeD | U92N | 09/N | N76D |
| Z | Z | Z | Z | lax. | L | Z | Z | 3C | Z | Z | 100 | IZ. | I. | IZ | Z | Z | 2 |

| Q12R | N76D | S103A | V104i | | | | | * |
|-------|-------|-------|--------|-------|-------|--|---|-------|
| C9/N | S103A | 71041 | S212P | E271V | | | | |
| N76D | S103A | V104I | N252K | N261Y | | | | |
| N76D | S103A | V104I | \$2421 | | | | | |
| N/6D | S103A | V104 | £2710 | | | *************************************** | | |
| Q12R | N76D | S103A | V104 | S2427 | | The second secon | | |
| N43S | M76D | S103A | V104I | N116K | N183i | | | |
| 09/N | S103A | V104I | G258R | | | *************************************** | | |
| N76D | S103A | V104 | E271G | | | Very pir very improperation as | | |
| GETR | N76D | S103A | V104I | | | V.AMPERINGE SELECTION CONTRACTOR | | |
| T38S | N76D | S103A | V104 | Q182R | Y263H | | | |
| N76D | S103A | V104i | Q182R | A272S | | | | |
| 09ZN | S103A | V104I | Q109R | 12467 | | | | - |
| N76D | S87G | S103A | V104I | C206R | H249Q | \$2656 | | |
| 09/N | S103A | V1041 | Q137R | N238Y | E271V | | | |
| S103A | V104 | A228T | | | | | | |
| G9/N | S103A | V104I | Q182R | 11987 | | | *************************************** | |
| L21M | M76D | S103A | V104! | Q182R | | | | |

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| S103A | | M1198 | Li | | | | | |
|-------|--------|-------|--------|-------|-------|--|------|---------------|
| S103A | V104 | Q137R | N248S | | | | | |
| N76D | S103A | V104 | Q206R | | | | | |
| S103A | V104 | Q206R | | | | | | ************* |
| S103A | V104E | S212P | G258R | | | | | |
| 09/N | S103A | V104I | E271G | | | | | |
| S103A | V104I | Q206E | N261D | | | | | |
| N76D | S103A | V104I | Q206E | | | | | |
| 077N | S103A | V104I | Q206E | | | | | |
| S103A | V104 | A158E | | | | | | |
| S103A | V104I | Q206E | | | | | | |
| Q9/N | S103A | V1041 | G159D | L217E | K251Q | | | |
| N76D | \$103A | V104 | G159D | 1217E | N252D | | | |
| U77D | \$103A | V104I | A133T | N185D | K251T | | | |
| S103A | V104 | G159D | C206E | V244A | | | | - |
| N76D | S103A | V104I | \$188E | | | | | |
| N76D | \$103A | V104I | A158E | | | | - | |
| DZZN | S103A | V104 | N185D | | | | | |
| | | | | | | The second secon | | |

| S103A V104I Q206E K251T | V104 L111M G159D | V104 G159D Q236H | V1041 G159D | S103A V104l G159D | V1041 G159D | G146S G159D | G159D N238S | G159D T224A | S212P V288F E271V | V104 | V104 S212P E271V | S212P Q245L E271V | T134S S141N S212P E271V | S212P Q236L N243S E271V | Q109R Q245R | 7470 0040 | |
|-------------------------|-------------------|-------------------|-------------|-------------------|-------------|-------------|-------------|-------------|-------------------|-------|-------------------|-------------------|-------------------------|-------------------------|-------------|-----------|------|
| V104 | S103A | S103A | S103A | N76D | S103A | V104I | V104I | V104I | V104I | S103A | S103A | 7104 | V104I | V10AI | V104f | 173040 | 200 |
| S103A | N76D | N76D | N76D | N62H | 09/N | S103A | S103A | S103A | S103A | E89A | S87R | S103A | S103A | S103A | S103A | C402A | 5000 |
| 09/N | A48T | V68A | L42V | Q12H | 1421 | N76D | N76D | 092N | N76D | N76D | N76D | M76D | N76D | N76D | N76D | COCK | 200 |

| V68A | U9/N | \$103A | V104 | Q236H | | | | | |
|--------|-------|--------|--------|-------|-------|-------|-------|---|-------|
| V68A h | N76D | S103A | V104 | G159D | Q236H | E271V | | | |
| V68A h | 09/N | S103A | V104 | G159D | Q236H | Q245R | | | |
| V68A N | N76D | S103A | V104I | G159D | 12171 | О236Н | E271V | | |
| H17a V | V68A | N76D | S103A | V104i | | | | | |
| V68A N | N76D | S103A | V104 | | | | | *************************************** | |
| V68A N | Q9/N | S103A | V104 | G159D | Q236R | | | | |
| V68A | LZSR | N76D | S103A | V104 | G159D | Q236H | | | |
| V68A N | U3/N | N76D | S103A | A114V | V1211 | G159D | O236H | Q245R | |
| Q12R | V68A | N76D | \$103A | V104I | G159D | Q236H | | | |
| V68A h | G9/N | S103A | V1048 | G159D | Y2098 | Q236H | T253K | *************************************** | |
| V68A h | 09/N | S103A | V104I | N117K | G158D | N184S | Q236H | *************************************** | |
| V68A | N76D | S103A | V104 | G159D | Q236H | N2431 | | | |
| V68A h | M76D | S103A | V104 | G159D | Q236H | O245L | | | |
| V68A N | M76D | S103A | V104I | A142V | G159D | | | | |
| V68A N | N76D | S103A | V104 | N123S | G159D | Q236H | H249Y | | |
| V68A N | N76D | S103A | V104 | G159D | O236H | H2490 | | *************************************** | |
| S G9/N | S103A | 71041 | M222S | Q245R | | | | | |
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| H249R | | TOTAL DATA DE LA CONTRACTOR DE LA CONTRA | K237R Y263F | | £2710 | | | N248S | 200000000000000000000000000000000000000 | Q236H Q245R N261D | G159D Q236H Q245R T255S | Q236H Q245R R247H | A174V N204D Q236H Q246R | N204D Q236H Q245R | G159D N218D Q236H Q246R | A232V 0236H 0246R |
|------------|-------|--|-------------|-------|-------|-------|-------|-------|---|-------------------|-------------------------|-------------------|-------------------------|-------------------|-------------------------|-------------------|
| M222S | M222S | Y263F | M222S | M222S | MZZZS | M2228 | M2228 | MZZZS | H249R | G159D | S141N | G159D | G159D | G159D | A133V | C14500 |
| Q12R | N173R | M222S | V104I | Q109R | Q109R | V104 | Q137R | Q109R | M2228 | V104I | V1041 | V104! | V1048 | V1041 | V104! | 171031 |
| · | 2017 | 2012 | S103A | V104! | 71041 | S103A | V104I | V104I | V104 | S103A | S103A | S103A | S103A | S103A | S103A | 64030 |
| S103A V104 | S103A | S103A | N76D | S103A | S103A | U9/N | S103A | S103A | S103A | N78D | N76D | N76D | 09/N | U9/N | 09/N | 81760 |
| 09/N | 09/N | C97N | L21M | CI9ZN | Q9/N | GenR | D9/N | Q9/N | 09/N | V68A | V68A | V68A | V68A | V68A | V68A | VERA |

| | | 5R | | 5R 7260A | *************************************** | ************************************** | | | | 2% | | 2K | 2K | | 2× | 2K R275S |
|---------------|-------|----------------|-------------|----------|---|--|-------|-------|-------|----------|-------|----------|----------|----------|----------|----------|
| | | 6H Q245R | 2X | 6H 0245R | - | | | - | | 8D N252K | | SR N252K | SR N252K | SR | 5R N252K | 5R N252K |
| | | V Q236H | R NZ52K | √ Q236H | Or. | - | o: | - | - | R N248D | e. | H 0245R | H 0245R | H 0245R | H Q245R | H Q245R |
| | | A232V | Q236H Q245R | A232V | Q245R | ļ | Q245R | - | | Q245R | Q245R | Q236H | Q236H | Q236H | Q236H | Q236H |
| M222S Q245R | | G159D | Q236H | T213R | V244§ | Q245R | M222S | | | Ф236Н | Q236H | A232V | A232V | A232V | A232V | A232V |
| M222S | Q245R | V10 <u>8</u> 1 | A232V | G159D | M2228 | P210T | S130T | V104 | | A232V | A232V | G159D | G159D | G159D | G159D | G159D |
| V104 | A232V | S103A | G159D | V104 | 1104T | M2228 | 1104T | S103A | N184D | G159D | G159D | N140D | V104 | V104 | V102 | V104 |
| S103A | V104 | N76D | 7104 | S103A | S103A | S103A | S103A | N76D | S103A | V104 | V104I | V104I | \$1034 | \$103A | S103A | S103A |
| N76D | S103A | V68A | S103A | N76D | 09/N | Q9/N | N76D | V68A | Q9/N | S103A | S103A | S103A | V68A | V68A | V68A | S87G |
| Q12R | 09/N | S24T | V68A | V68A | Q12R | Q12R | Q12R | T22K | V68A | V68A | V68A | V68A | N43S | ZZZ X | N43D | V68A |

| Q12R | N76D | N76D S103A | 11047 | S130T | A215V | A215V M222S Q245R | Q245R | | | | |
|------|--------|--------------|-------|--------|-------|-------------------|-------|-------|---|---|--|
| Q12R | N76D | S103A | 1104T | S130T | M2228 | V227A | Q245R | L262S | | | |
| Q12R | N76D | S103A | 11047 | S130T | A215T | M2228 | Q245R | | *************************************** | | |
| Q12R | N76D | S103A | 11047 | S130T | M2225 | Q245R | N261D | | | | |
| 09/N | \$103A | 1104T | S130T | W2228 | Q245R | | | | <u> </u> | - | |
| Q12R | N76D | S103A | 11047 | S130T | N218D | M222S | Q245R | 12628 | NZ69D | | |
| Q12R | S57P | C9ZN | S103A | 11047 | S130T | M2228 | Q245R | K251Q | | | |
| O12R | N76D | S103A | 11047 | S130T | R170S | N185D | M2228 | N243D | Q245R | *************************************** | |
| Q12R | 09/N | \$103A | HOAT | \$1301 | W222S | Q245R | VZ68A | | | | |
| Q12R | N76D | S103A | 1104T | S130T | M2228 | P210S | Q245R | | | | |
| V68A | S103A | V104 | G159D | A232V | Q236H | Q245R | L257V | | | | |
| V68A | S103A | V104I | U116D | G159D | A232V | Q236H | Q245R | | - | - | |
| V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | N248D | | <u></u> | | |
| R10C | V68A | S103A | V104I | G159D | A232V | Q236H | Q245R | | | | |
| V68A | S103A | V104I | G159D | VZ03E | A232V | O236H | Q245R | | | | |
| V68A | S103A | V104I | G159D | A232V | Q236H | K237E | Q245R | | | | |
| V68A | 09/N | 179N | S103A | V104 | G159D | A232V | Q236H | O245R | | | |
| V68A | S103A | V104 | G159D | N183D | A232V | C236H | Q245R | | | | |

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| Q245R | | | | | | | Q245R | 12577 | | R275H | | L257V | | O245R | Q245R | Q245R | O236H |
| Q236H | Q245R | Q245R | Q245R | Q245R | N248S | Q245R | Q236H | Q245R | | L257V | | Q245R | 12577 | Q236H | Q236H | Q236H | A232V |
| A232V | Q236H | Q236H | Q236H | Q236H | Q245R | Q236H | A232V | Q236H | L257V | Q245R | | Q236H | Q245R | A232V | A232V | A232V | Y214£ |
| Q2061. | A232V | A232V | A232V | A232V | Q236H | A232V | P210R | A232V | Q245R | Q236H | | A232V | Q236H | Y209W | G211R | 62117 | G159D |
| A174V | S188C | A230T | G159D | A215T | A232V | G159D | G159D | G159D | Q236H | A232V | R275H | T224A | A232V | G159D | G159D | G159D | V104E |
| G159D | G159D | G159D | V104E | G159D | G159D | V104I | V104I | V104I | A232V | G159D | L257V | G159D | G159D | V104 | V104I | V104 | S103A |
| V104! | V104I | V104I | \$103A | V104I | V104I | S103A | S103A | S103A | V104I | V104I | V104I | V104I | V104E | S103A | S103A | S103A | N76D |
| S103A | S103A | S103A | A98T | S103A | S103A | 09/N | C9/LN | 09/N | S103A | S103A | S103A | S103A | S103A | C9/N | 09/N | C9/N | V68A |
| V68A | V68A | V68A | V68A | V68A | V68A | V68A | V68A | V68A | N76D | V68A | N76D | V68A | 09ZN | V68A | V68A | V68A | 0108 |

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|-------------------|-------|-------|--|-------|-------|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------------|
| ***** | | | | | | The second secon | | | | | | | | - | | | 02400 |
| | | S259G | T260V | | | | | Q245R | | | K251R | A272S | Q245R | | | | 30000 |
| Q245R | O245R | Q245R | 0245R | N261G | NZ61W | | Q245R | Q236H | | | N248S | Q245R | Q236H | S256R | Q245R | Q245R | X MANUAL F |
| Q236H | Q236H | Q236H | Q236H | Q245R | Q245R | | О236Н | A232V | - | Q245R | Q245R | Q236H | A232V | Q245R | Q236H | Q236H | 274000 |
| A232V | A232V | A232V | A232V | Q236H | Q236H | Q245R | A232V | G159D | | Q236H | Q236H | A232V | Q206L | Q236H | A232V | A232V | |
| A215R | G159D | G159D | G159D | A232V | A232V | S242P | P210L | 19012 | Q245R | A232V | A232V | G159D | N183K | A232V | Q206R | G159D | 00000 |
| G159D A215R A232V | V1041 | V104I | V104I | G159D | G159D | Q236H | G159D | S103A | Q236H | Y192F | G159D | V104I | G159D | G159D | G159D | V104I | 2000 |
| V104 | S103A | S103A | S103A | V104I | V104I | A232V | V104I | C9/N | A232V | G159D | V1471 | S103A | V104I | V104I | V104I | S103A | 10000 |
| N76D S103A | N76D | U9ZN | U9ZN | S103A | S103A | V104 | S103A | V68A | V104 | V104 | V104 | 09/N | S103A | S103A | S103A | M76D | |
| M76D | V68A | V68A | S87R | N76D | M76D | S103A | N76D | A48V | S103A | S103A | S103A | V68A | U36D | M76D | N76D | V68A | - |
| V68A | Q12R | G20R | V68A | V68A | V68A | N76D | V68A | Q12R | M76D | N78D | N76D | Q12R | V68A | V68A | V68A | K27R | |

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| | | *************************************** | N252K | | | | | | | | | | | N252K | | | |
| N252K | N252K | N252K | N248D | | N252K | N252K | N252K | N252K | N261D | N252K | N252K | N252K | N252K | N248D | NZ52K | N252K | NC2CN |
| N248D | N248D | N248D | Q245R | | N248D | N248D | N248D | N248D | N252K | N248D | N248D | N248D | N248D | Q245R | N248D | N248D | NOZEN |
| Q245R | Q245R | Q245R | Q236H | N252K | Q245R | Q245R | Q245R | Q245R | N248D | Q245R | O245R | Q245R | Q245R | Q236H | Q245R | Q245R | COAKED |
| O236H | Q236H | Q236H | A232V | N248D | Q236H | Q236H | Q236H | Q236H | Q245R | Q236H | Q236H | Q236H | Q236H | A232V | Q236H | Q236H | 0038H |
| A232V | A232V | A232V | N184D | Q245R | A232V | A232V | A232V | A232V | Q236H | A232V | A232V | A232V | A232V | P210L | A232V | A232V | ADSON DOSELL |
| G159D | G159D | \$212P | G159D | Q236H | Y209W | G159D | G159D | Y209F | A232V | N185D | P210R | P210T | P210S | D281N | P210L | \$212A | 20190 |
| <u>2</u> | V104I | G159D | N66S | A232V | G159D | Q109R | V104I | G159D | 21605 |
| S103A | S103A | V1041 | V104I | G159D | V104I | V104i | S103A | V104I | V104 | V104 | V104I | V104 | V104I | V104 | V104 | V104I | 3746.48 |
| V68A | V68A | S103A | S103A | V104 | S103A | S103A | V68A | S103A | 04036 |
| G61E | N43D | V68A | V68A | S103A | VEBA | V68A | GZOR | V68A | VBBA | V68A | Vesy |

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| N252K | N252K | | N252K | N252K | N252K | N252K | N252K | N252K | NZ52K | NZ52K | N252K | N252K | N252K | N252K | | | 3,200,000,000 |
| N248D | N248D | N252K | N248D | N248D | N248D | N248D | N248D | N248D | N248D | N248D | N248D | N248D | K251V | N248D | N252F | N252L | 207014 |
| Q245R | Q245R | N248D | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | N248D | O245R | N248D | N248D | 01.00 |
| Q236H | Q236H | Q245R | Q236H | Q236H | O236H | Q236H | Q236H | Q236H | Q236H | Q236H | Q236H | Q236H | Q245R | Q236H | Q245R | Q245R | Carried Court |
| A232V | A232V | Q236H | A232V | A232V | A232V | A232V | A232V | A232V | A232V | A232V | A232V | A232V | Q236H | A232V | Q236H | Q236H | 40000 |
| \$212E | T213E | A232V | T213E | T213R | 72136 | A215V | A215R | S216T | S216V | S216C | G159D | N173D | A232V | Q206R | A232V | A232V | 00000 |
| G159D | G159D | T2138 | G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | V104 | G159D | G159D | G159D | G159D | G159D | ****** |
| 2 2 2 2 3 | V104I | V104 | 2102 | V104I | V104I | V104I | V104I | V104I | V104I | V104I | S103A | V104I | V104I | V104 | V104 | V104 | 100.0 |
| \$103A | S103A | S103A | A103V | S103A | S103A | S:103A | S103A | S103A | S103A | S103A | V68A | S103A | S103A | S103A | S103A | S103A | 1000 |
| V68A | V68A | V68A | V68A | V68A | V68A | V68A | V68A | V68A | V68A | V68A | G20A | V68A | V68A | V68A | V68A | V68A | - |

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| | | | | | | *************************************** | | | | | | | | | | | T260A |
| | | | | | | | N269D | T260E | | | | | | | | | Q245R |
| T255V | S256N | S256E | S256R | T260R | L257R | G258D | NZ52K | NZ52K | N261R | N261D | N252K | | | | N252K | | O236H |
| N252K | N252K | N252K | N252K | N252K | N252K | N252K | N248D | N248D | N252K | N252K | N248D | | | N252K | N248D | N252K | A232V |
| N248D | N248D | N248D | N248D | N248D | N248D | N248D | Q245R | Q245R | N248D | N248D | Q245R | N252K | N252K | N248D | Q245R | N248D | N218S |
| Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q236H | Q236H | Q245R | Q245R | Q236H | N248D | N248D | Q245R | Q236H | Q245V | T213R |
| Q236H | Q236H | Q236H | Q236H | Q236H | Q236H | Q238H | A232V | A232V | Q236H | Q236H | A232V | Q245R | Q245R | Q236R | A232V | Q236H | G159D |
| A232V | A232V | A232V | A232V | A232V | A232V | A232V | G159D | G159D | A232V | A232V | G159D | Q236H | Q236H | A232V | G159D | A232V | V104 |
| G159D | G159D | G159D | G159D | G159D | G459D | G159D | V104I | N116S | G159D | G159D | V104 | A232V | A232S | G159D | V104 | G159D | S103A |
| V104I | V104I | V104I | V10AI | V104 | V104I | V104I | S103A | V104I | V104I | V104I | S103A | V104 | G159D | V104 | S103A | V104I | S101T |
| S103A | S103A | S103A | S103A | S103A | S103A | S103A | V68A | S103A | S103A | S103A | 09/N | S103A | 2102 | S103A | V68A | S103A | G9/N |
| V68A | V68A | V68A | V68A | V68A | V68A | V68A | >8 | V68A | V68A | V68A | V68A | V68A | S103A | VesA | N18S | V68A | V68A |

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| | | T250A | | | | N252K | | | | | | | | | | | - |
| | N252K | Q245R | N252K | | N252K | N248D | | | | N252K | N252K | NZ5ZK | | | | | |
| N252K | N248D | Q236H | N248D | | N248D | Q245R | N252K | | N252K | N248D | N248D | N248D | - | | | | |
| N248D | Q245R | A232V | Q245R | | Q245R | Q236H | N248D | N252K | N248D | Q245R | Q245R | Q245R | N252K | N252K | N252K | N252K | 4300000 |
| Q236H Q245H N248D | Q236H | T213R | Q236H | Q245R | Q236H | A232V | Q245R | N248G | Q245R | Q236H | Q236H | Q236H | N248D | N248D | N248D | N248D | Ken and |
| Q236H | A232V | P210L | A232V | Q236H | A232V | G159D | Q236H | 0245R | C236H | A232V | A232V | A232V | Q245R | Q245R | Q245R | Q245R | COLUMN COLUMN |
| A232V | G159D | G159D | G159D | A232V | G159D | Q137R | A232V | Q236H | A232V | \$1600 | V104 | S167F | Q236H | Q236H | Q236H | Q236H | 1 |
| A228V | V104I | V104I | V104I | P210I | S130A | A133S | G159D | A232V | N218S | G159D | S103A | G159D | A232V | A232V | A232V | A232V | ,,,,,,,, |
| G159D | \$103A | S103A | S103A | V205i | V104 | V104 | A133V | G159D | G159D | V104I | D9/N | V104 | G159D | G159D | G159D | G159D | |
| 202 | G9/N | G683 | U292N | G159D | S103A | S103A | V104I | V104E | V104I | S103A | V68A | S103A | V104I | V104 | V104I | V104I | 4 |
| S103A | V68A | 097N | V68A | V104I | V68A | V68A | S103A | S103A | S103A | V68A | G61E | V68A | S103A | S103A | S103A | S103A | |
| V68A | T33S | V68A | G61E | S103A | GGIE | G61E | G61E | V68A | V68A | G61E | 83. | GB1E | G97E | A98D | 399E | STOTE | 0,000 |

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| | | | | | | | | | N248D | N252K | N252K | N252K | | | | | T260A |
| N252K | N252K | N252K | NZ61R | N252K | N252K | N252K | NZ52K | N252K | O245R | N248D | N248D | N248D | N252K | N252K | N262K | N252K | Q245R |
| N248D | N248D | N248D | NZ52K | N248D | N248D | N248D | N248D | N248D | Q236H | Q245R | Q245R | Q245R | N248D | N248D | N248D | N248D | Q236H |
| Q245R | Q245R | Q245R | N248D | Q245R | Q245R | Q245R | Q245R | Q245R | A232V | Q236H | Q236H | Q236H | Q245R | Q245R | Q245R | Q245R | A232V |
| Q236H | Q236H | О236Н | Q245R | Q236H | Q236H | Q236H | Q236H | Q236H | T213R | A232V | A232V | A232V | Q236H | Q236H | Q236H | Q236H | 1213R |
| A232V Q236H Q245R N248D | A232V | A232V | Q236H | A232V | A232V | A232V | A232V | A232V | G159D | T213R | L217E | Q206R | A232V | A232V | A232V | A232V | G159D |
| V104 G159D | G159D | G159D | A232V | G159D | G159D | N184D | S166D | L217E | V104I | G159D | Q206R | G159D | G159D | G159D | G159D | G159D | V1041 |
| V104 | \$106E | Q109E | G159D | Q109R | V104 | G159D | G159D | G159D | S103A | V104I | G159D | V104I | \$1306 | P131V | V104I | V104! | S103A |
| S103A | V104 | V104! | V1046 | V104I | S103A | 7104 | V104I | V104I | N62D | S103A | V104 | S103A | V104 | V104 | S103A | S103A | Q9/N |
| G102A | S103A | S103A | \$103A | S103A | N62D | S103A | S103A | S103A | GZOR | N62D | S103A | N62D | S103A | S103A | K27N | T38G | T38A |

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|-------|-------|-------|-------|-------|-------|----------|-------|--------|-------------------------|-------|-------|---------------------------------------|-------|-------|---|-------|---------|
| | 4 | Ą | A | | | | | | | | | | | | | | |
| E271G | T260A | T260A | T260A | | | | | | | | | | | | | | |
| T260A | Q245R | Q245R | Q245R | T260A | | | | - | operation of the second | | | - | | | *************************************** | | |
| Q245R | Q236H | Q236H | Q236H | Q245R | T260A | T260A | | | | | | · · · · · · · · · · · · · · · · · · · | | | | L257V | 1,75201 |
| Q236H | A232V | A232V | A232V | Q236H | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | | T260A | | Q245R | 03760 |
| A232V | T213R | T213R | T213R | A232V | Q236H | Q236H | O236H | Q236H | Q236H | Q236H | Q236H | Q236H | | Q245R | | Q236H | Macco |
| T213R | Y209W | P210 | V205I | P210 | A232V | A232V | A232V | A232V | A232V | A232V | A232V | A232V | Q245R | Q236H | Q245R | A232V | VICEA |
| G159D | G159D | G159D | G159D | G159D | T213R | T213R | Y209W | P210I | A230V | L126F | V2051 | P2101. | Q236H | A232V | O236H | A174V | 0.10.40 |
| V104 | V104I | V104! | V104i | V1041 | G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | A230V | G159D | A232V | G159D | CARON |
| S103A | S103A | S103A | S103A | S103A | V104I | V104I | V104 | V104I | V104I | V1041 | V104I | V104I | G159D | V104 | G159D | V104 | 1740.45 |
| N76D | U29ZN | N78D | N78D | N78D | S103A | \$103A | S103A | \$103A | S103A | S103A | S103A | S103A | V104I | S103A | V104I | S103A | 64000 |
| V68A | V68A | V68A | V68A | V68A | V68A | N76D | V68A | V68A | V68A | V68A | V68A | V68A | S103A | V68A | S103A | V68A | YOUN |

| | | | | | | *************************************** | | | | | | | | | *************************************** | | > |
|-------|-------|-------|-------|-------|-------|---|-------|-------|-------|-------|-------|-------|-------|--------|---|--------|---|
| | | NZ61W | | | | | T260A | | | | | | | | T260A | | |
| | | T260A | | | | | Q245R | T260A | | T260A | | Q245R | L257V | | Q245R | | |
| 1257 | | Q245R | N261W | | N252K | | Q236H | O245R | | Q245R | T260A | Q236H | Q245R | 1.257V | Q236H | Q245R | - |
| Q245R | | Ф236Н | L257V | T260A | N248D | 12577 | A232V | Q236H | | Q236H | Q245R | A232V | Q236H | Q245R | A232V | Q236H | |
| Q236H | L257V | A232V | Q245R | Q245R | Q245R | Q245R | T213R | A232V | L257V | A232V | Q236H | P210I | A232V | O236H | P210f | A232V | |
| A232V | Q245R | T213R | Q236H | Q236H | Q236H | Q236H | P210L | T213R | Q245R | T213R | A232V | Y209W | P210I | A232V | Y209W | P210 | *************************************** |
| Y209W | Q236H | G159D | A232V | A232V | A232V | A232V | G159D | Y209W | Q236H | P2101 | Y209W | V205I | Y209W | Y209W | VZ0SI | Y209W | *************************************** |
| G159D | A232V | V104I | G159D | T213R | P210I | Y209W | V104I | G153D | A232V | V205I | V205I | G159D | V205I | V205I | G159D | V205I | ***************** |
| V104I | G159D | S103A | V104I | G159D | G159D | G159D | S103A | V1041 | Y209W | G159D | G159D | V104I | G159D | G159D | V104I | G159D | |
| S103A | V104 | Q9ZN | S103A | V104! | V104I | V1048 | U3/8D | S103A | V104! | V104 | V104 | S103A | V104I | V104! | S103A | V104I | |
| V68A | S103A | V68A | V68A | S103A | S103A | S103A | V68A | Q12R | S103A | S103A | S103A | V68A | S103A | S103A | V68A | \$103A | - |

| | | | | | | | N252K | N252K | N252K | | | | | *************************************** | | S256R | N252K |
|-------|---------|-------|-------|-------|-------|--------|-------|--------|--------|-------|-------|-------|-------|---|-------|-------|--------|
| | | | | N252K | NZGTW | N252K | N248D | N248D | N248D | N252K | | | | | | NZ52K | N248D |
| | | | Q245R | N248D | L257V | N248D | Q245R | Q245R | Q245R | N248D | N252K | N252K | N252K | N252K | N252K | N248D | O245R |
| Q245R | Q245R | - | Q236H | Q245R | Q245R | Q245R | Q236H | Q236H | Q236H | Q245R | N248D | N248D | N248D | N248D | N248D | Q245R | O236H |
| O236H | Q236H | Q245R | A232V | Q236H | Q236H | Q236H | A232V | A232V | A232V | Q236H | Q245R | Q245R | Q245R | Q245R | Q245R | Q236H | ASSON |
| A232V | A232V | Q236H | Y209W | A232V | A232V | A232V | S212G | \$212G | \$212G | A232V | Q236H | Q236H | Q236H | V244T | V244A | A232V | T213D |
| P210 | G159D | A230V | G159D | G159D | G159D | \$2126 | G159D | G159D | G159D | T213R | A232V | A232V | A232V | Q236H | Q236H | T213R | C1507 |
| 2022 | \$1281. | G159D | V104I | V104I | V1041 | G159D | V104I | V104f | V104! | G159D | G159D | N184S | N184G | A232V | A232V | G159D | 174074 |
| G159D | 1,1041 | V104i | S103A | S103A | S103A | V104I | S103A | S103A | S:103A | V104I | P131V | G159D | G159D | G159D | G159D | V104 | S1034 |
| V104 | S103A | S103A | V68A | V68A | V68A | S103A | G102A | G102A | G102A | S103A | V104 | ¥102 | V104 | V104 | V104 | S103A | NESS |
| S103A | V68A | A48V | A48V | A48V | A48V | G102A | Q12R | S101G | A98L | G102A | S103A | S103A | S103A | S103A | S103A | N62D | 0400 |

| | | | - | | | | | T- | | | T | | Ī | | T | | T |
|-------|--------|-------|-------|--------|-------|--------|-------|-------|-------|---------------|-------|---------------|-------------|---------------|-------|--------|--------|
| | | | | | | | | | N252K | | | | | | | | |
| | | | | | N252K | | N252K | N252K | N248D | | | N252K | | | | NZSZK | N252K |
| M252K | N252K | N252K | N252K | N252K | N248D | N252K | N248D | N248D | Q245R | | | N248D | N252K | N252K | N252K | N248D | N248D |
| N248D | N248D | N248D | N248D | N248D | Q245R | N248D | Q245R | Q245R | Q236H | | | Q245R | N248D | N248D | N248D | Q245R | Q245R |
| Q245R | Q245R | Q245R | Q245R | Q245R | Q236H | Q236H | Q236H | C236H | A232V | - | | Q236H | Q245R | Q245R | Q245R | Q236H | Q236H |
| O236H | Q236H | Q236H | Q236H | O236H | A232V | A232V | A232V | A232V | T213R | N252K | | A232V | Q236H | O236H | O236H | A232V | A232V |
| A232V | A232V | A232V | A232V | A232V | S212G | \$212G | T213R | T213R | S212G | N248D | | T213R A232V | A232V Q236H | A232V Q236H | A232V | T213R | T213R |
| N185D | Q206E | 72130 | G159D | G159D | G159D | G159D | G159D | S212G | G159D | Q245R | Q245R | G159D | G159D | G159D | G159D | G159D | G159D |
| G159D | G159D | G159D | V104 | V104I | V104 | V104! | Q109R | G159D | V104E | A232V | A230V | S130G | S130G | S128G | S128L | V104I | \$1286 |
| V104i | V104I | V104f | S103A | S103A | S103A | S103A | V104I | V104I | S103A | G159D | G159D | V104I | V104I | V104I | V104I | S103A | V104I |
| S103A | \$103A | S103A | G102A | G102A | G102A | G102A | S103A | S103A | S101G | V104 <u>I</u> | V1041 | S103A | S103A | S103A | S103A | \$1016 | S103A |
| S101G | S101G | S101G | A981. | \$1016 | A98L | A98L | N62D | N62D | N62D | S103A | S103A | N62D | \$1016 | \$1016 | 81016 | NezD | NezD |

| 2 | S128L | G159D | IZ13R AZ3ZV | A232V | | | N248U | N252K | | |
|---------|--|-------|-------------|-------|-------------|-------|-------|---|-------|-------|
| G159D | | A232V | Q236H | Q245R | N248D | N252K | T260A | | | |
| P131V | į | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V104E | ļ | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| V104 | | G159D | A232V | Q236H | Q245R | N248D | N252K | | | |
| G159D 8 | L., | S212G | A232V | Q236H | Q245R | N248D | N252K | | | |
| G159D Y | Ļ | Y209W | A232V | Q236H | Q245R | N248D | N252K | | | |
| G159D F | <u></u> | P210I | A232V | Q236H | Q245R | N248D | N252K | *************************************** | - | |
| G159D | L | VZ05I | A232V | Q236H | Q245R | N248D | N252K | | | |
| G159D A | <u> </u> | A230V | Q236H | Q245R | | | | | - | |
| G159D / | 4 | A194P | A232V | Q236H | Q245R | N248D | N252K | | | |
| V104I | _ | G159D | A194P | A232V | A232V Q236H | Q245R | N248D | N252K | | |
| G159D / | | A230V | A232V | Q236H | Q245R | N248D | N252K | | | |
| G159D | ــــــــــــــــــــــــــــــــــــــ | N185D | Q206E | T213R | A232V | Q238H | Q245R | N248D | N252K | E271Q |

Example 2

5

10

A large number of the protease variants produced in Example 1 were tested for performance in two types of detergent and wash conditions using a microswatch assay described in "An improved method of assaying for a preferred enzyme and/or preferred detergent composition", U.S. Serial No. 60/068,795.

Table 5 lists the variant proteases assayed and the results of testing in two different detergents. For column A, the detergent was 0.67 g/l filtered Ariel Ultra (Procter & Gamble, Cincinnati, OH, USA), in a solution containing 3 grains per gallon mixed Ca²⁺/Mg²⁺ hardness, and 0.3 ppm enzyme was used in each well at 20°C. For column B, the detergent was 3.38 g/l filtered Ariel Futur (Procter & Gamble, Cincinnati, OH, USA), in a solution containing 15 grains per gallon mixed Ca²⁺/Mg²⁺ hardness, and 0.3 ppm enzyme was used in each well at 40°C.

Table 5

| 3 | T- | 1.1 | 1.85 | 1 20 | 1.67 | 1.42 | 1.80 | 1.78 | 1.34 | 1.67 | 0.53 | 0.20 | 1.41 | 0.47 | 1.28 | 0.09 |
|------|-------|---|---|--|-------|--------|---|-------|-------|--------|-------|-------|-------|-------|-------|-------|
| | - | 0 28 | 1.41 | 2.77 | 2.26 | 2.96 | 16: | 2.05 | 2 00 | 2.38 | 2.83 | 2.87 | 2.56 | 3.97 | 3.35 | 3.77 |
| | | | | - Constitution of the Cons | | | *************************************** | | | | - | | | | | NZSZK |
| | | | *************************************** | N252K | | N252K | NZ52K | | N252K | | - | | | R275H | L257V | N248D |
| | | | N252K | N248D | - | Q245R | Q245R | Q245R | Q245R | 1.2577 | N248D | Q245R | N252S | L257V | Q245R | Q245R |
| | | anaecontores riveres | Q245R | Q245R | Q245R | Q236H | Q236H | Q236H | Q236H | Q245R | Q245R | K237E | 0245R | Q245R | Q236H | Q236H |
| •••• | | | Q236H | Q236H | Q236H | A232V | A232V | A232V | A232V | Q236H | Q236H | Q236H | Q236H | Q236H | A232V | A232V |
| **** | | | A232V | A232V | A232V | G159D | G159D | G159D | G159D | A232V | A232V | A232V | A232V | A232V | 1224A | G159D |
| | - | *************************************** | G159D | G159D | G159D | N140D | V104I | V104 | V104 | G159D | G159D | G159D | G159D | G159D | G159D | V1041 |
| | V104I | A228T | V104I | V104I | V104I | V104I | S103A | S103A | S103A | Z104 | V104 | V104I | V104I | V104! | V104! | S103A |
| | S103A | V104I | S103A | S103A | S103A | \$103A | V68A | V68A | V68A | S103A | S103A | S103A | S103A | S103A | S103A | V68A |
| •••• | N76D | S103A | V68A | V68A | V68A | V68A | N43S | N43K | N43D | V68A | V68A | V68A | V68A | V68A | V68A | G61E |

| 0.47 | 1.46 | 0.28 | 0.33 | 0.36 | 0.43 | 0.32 | 0.33 | 0 13 | 0.35 | 0.55 | 0 25 | 0.48 | 0.19 | 0.29 | 0.53 | 0.12 | 0.43 |
|-------|--------|-------|---|-------|-------|---------------------------|-------|-------|-------|-------|-------------------|-------|-------|-------|--------|-------|-------|
| 3.50 | 2.81 | 1.56 | 1.22 | 1.13 | 1.22 | 1.52 | 154 | 1.04 | 1.09 | 1 | 1.50 | | 1.05 | 1.32 | 1.19 | 0.92 | 1,31 |
| N252K | N252K | | - | | | | | | | | | | | | | | |
| N248D | N248D | | *************************************** | - | | | | | | | TOTAL DANGE LANGE | | | - | | | |
| Q245R | Q245R | | *************************************** | | | | | | - | - | | | | | | | |
| Q236H | Q236H | | | | | - Carrier Carrier Carrier | | | | | | | | | | | |
| A232V | A232V | | | | | | | | | | | | | | | | |
| G159D | \$212P | | | | N248D | | | | A174V | K237Q | | | | | | | |
| V104 | G159D | V104I | V104I | V104I | 7104 | V104I | N261D | S216C | V104I | V104I | N183D | V104I | V104I | N184D | N252D | S259C | K251T |
| S103A | V104 | S103A | S103A | S103A | S103A | S103A | V104 | 7104 | S103A | S103A | V104 | S103A | S103A | V104I | V104I | V104I | V104J |
| V68A | S103A | ASSE | 09/N | UZZN | 09/N | 09/N | S103A | S103A | 077N | N76D | S103A | N76D | M76D | S103A | \$103A | S103A | S103A |
| N43D | V68A | M76D | V4E | N76D | A16T | A1E | N76D | N76D | M76D | T38S | N76D | R19L | R19C | C9/N | G9ZN | 09/N | 09ZN |

| 0.98 | 0.37 | 0.16 | 0.99 | 0.23 | 0.28 | 0.71 | 126 | 0.87 | 1.07 | 1.31 | 1.35 | 1.02 | 0.92 | 1.25 | 1.32 | 1.10 | 1.17 |
|-------|--------|-------|-------|-------|-------|-------|-------|--------|----------|----------|--------|-------|---|---|--------|-------|-------|
| 3 | 1.70 | 1.12 | 1.13 | 1.88 | 1.29 | 0.52 | 0 23 | 0.21 | 0.24 | 0.61 | 0.69 | 0.37 | 0.98 | 0 63 | 0.49 | 0.39 | 0.34 |
| | | | | | | | | *** | | - | | | | | | | |
| | | | | | | | | | | | | | | *************************************** | | | |
| | | * | | | | - | | | <u> </u> | <u> </u> | | | | | | | |
| | | | | - | | | | | - | <u> </u> | | | - | | | - | - |
| | | - | - | - | | | _ | - | | | | - | - | - | - | | - |
| | - | - | | - | - | - | | - | | | | | | | - | | |
| | | | | | | | - | | | | | | *************************************** | | | N183 | |
| | N185D | T274A | | | K237E | | | N204T | | | E271V | N281Y | | | \$2421 | N116K | |
| V104 | V104I | K237E | A228V | G8919 | V104I | S130L | Q109R | V104I | D181N | V104I | \$212P | N252K | S242T | E271Q | V104 | V104 | G258R |
| S103A | \$103A | V104I | V104E | V104I | S103A | V104I | 14017 | \$103A | V104I | S103A | V104j | V104! | V104I | V1041 | S103A | S103A | V104I |
| P86S | U3/2N | S103A | S103A | S103A | M76D | S103A | S103A | S99R | S103A | N78D | S103A | S103A | S103A | \$103A | 09/N | 09/N | S103A |
| M76D | 1727 | N76D | U9ZN | D92N | HIZE | N76D | N76D | N76D | M76D | Q12R | N76D | N76D | 09ZN | G92N | O12R | N43S | N76D |

| 0.57 1.25 | 0.22 0.95 | 0.24 0.38 | 0.13 0.91 | 0.16 1.02 | 031 101 | 0.33 1.02 | 0.38 1.06 | 0.84 1.26 | 1.97 0.04 | 1.51 0.05 | 1,40 0.04 | 1.95 0.16 | 2.41 0.88 | 1,34 0.03 | 1.78 0.04 | 2,16 0.04 | |
|-----------|-----------|-----------|-----------|-----------|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-----------|-----------|--|
| | | | | | | | | | | | | | | N185D K251T | | V244A | |
| | 1198V | Q182R | Q137R | N248S | Q206R | | G258R | E271G | NZ61D | Q206E | Q206E | | | A133T N1 | N261D | Q206E V2 | |
| E271G | Q182R | V104I | M119I | Q137R | V104I | Q206R | S212P | V104I | CZOSE | V104I | V104I | A158E | Q206E | V104E | Q206E | G159D | |
| V104I | V104 | S103A | 4012 | V104I | S103A | V104 | V104 | S103A | V104I | \$103A | S103A | V104I | V104 | S103A | V104 | V104 | |
| S103A | S103A | N76D | S103A | S103A | N76D | S103A | S103A | M76D | S103A | M76D | U77D | S103A | S103A | 022N | S103A | S103A | |
| M76D | M76D | L21M | N76D | M76D | A13T | 09ZN | M76D | T58S | N76D | V4E | M76D | N76D | M76D | 09/N | 097M | N76D | |

| 000 | 90.0 | 0.16 | 0.09 | 0.17 | 0.14 | 0.18 | 0.19 | 0.15 | 0.07 | 1.42 | 2.03 | 1.79 | 1.78 | 1.21 | 0.78 | 0.44 | 0.45 |
|---------|---|--------|----------|-------|---|----------|-------|----------|---|--------|---|----------|--|--|-------|-------|-------|
| 2.06 | 1.73 | 2.04 | 3.20 | 1.83 | 142 | 1.86 | 1.87 | 1.90 | 1.61 | 0.44 | 0.39 | 0.62 | 0.11 | 0.12 | 1.63 | 2.37 | 2.97 |
| ******* | | | <u> </u> | | | | | | | | | | | | | | |
| ••••• | - | - | - | - | <u> </u> | <u> </u> | - | <u> </u> | | - | | <u> </u> | | | | _ | |
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| | | | | | *************************************** | | | - | - | | *************************************** | | | - Andreas - Andr | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | *************************************** | | | | | | E271V |
| | *************************************** | G159D | Q236H | | G159D | | | | *************************************** | E271V | E271V | E271V | | | | | O236H |
| A158E | K251T | L1111M | G159D | G159D | V104I | G159D | G159D | N238S | T224A | V268F | \$212P | Q245L | Q245R | P210L | V104I | Q236H | G159D |
| V104i | Q206E | V104 | V104I | V104I | S103A | V104i | G146S | G159D | G159D | \$212P | V104i | \$212P | Q109R | Q109R | S103A | V104I | V104I |
| S103A | V104 | S103A | S103A | S103A | Q9/N | S103A | V104I | V104I | V104I | V104I | S103A | V104 | V104 | V104 | M76D | S103A | S103A |
| D97N | S103A | CI9ZN | 09/N | 09/N | N62H | N76D | S103A | S103A | S103A | \$103A | S87R | \$103A | S103A | S103A | N628 | U32N | Q9/N |
| V4E | M76D | A48T | V68A | 1.427 | Q12H | 1421 | 09/N | C19/LN | 092N | G97N | 092N | M76D | C92N | N76D | G20V | V68A | V68A |
| L | | .l | <u></u> | | | | .i | | .i | | .i | | ــــــــــــــــــــــــــــــــــــــ | | | | -l |

| 0.63 | 0.12 | 0.38 | 0.61 | 0.11 | 0.14 | 0.40 | 0.34 | 0.03 | 0.06 | 0.57 | 0.03 | 0.03 | 0 04 | 0 03 | 0.62 | 0.03 | 0.02 |
|-------|-------|---|--------|-------|--|---|-------|---|---|---|---|---|-------|---|-------|-------|-------|
| 3.00 | 2.71 | 2.46 | 2.46 | 331 | 3.06 | 3.11 | 3.12 | 3.18 | 2.78 | 2.49 | 3.37 | 3.11 | 3,15 | 3.31 | 3.26 | 2.78 | 3.28 |
| | | Market Control | | | and an | | | | - | | | | | | | | |
| | | | | | | *************************************** | - | - parameter and | *************************************** | | *************************************** | *************************************** | | *************************************** | | | |
| | | | | | | Q245R | | | | | | | | | T255S | | Q245R |
| | E271V | *************************************** | - | | | Q236H | | T253K | Q236H | *************************************** | | H249Y | | N261D | Q245R | R247H | Q236H |
| Q245R | O236H | | | | Q236H | G159D | Q236H | Q236H | N184S | | 02451 | Q236H | H249Q | Q245R | Q236H | Q245R | N204D |
| Q236H | 12171 | | | Q236R | G159D | V1211 | G159D | Y209S | G159D | | O236H | G159D | Q236H | O236H | G159D | Q236H | A174V |
| G158D | G159D | V104I | | G159D | V104I | A114V | V104I | G159D | N117K | Q236H | G159D | N123S | G159D | G159D | S141N | G159D | G159D |
| | V104I | S103A | V104! | V104! | S103A | V104 | S103A | V104 | V104I | V104I | V104I | V104I | V104I | V104I | V104I | 7104 | V104I |
| S103A | S103A | M76D | \$103A | S103A | 09ZN | S103A | U36N | S103A | S103A | \$103A | S103A | S103A | S103A | S103A | S103A | S103A | S103A |
| N760 | 09/N | V68A | U36D | M76D | L75R | Q9ZN | V68A | Q9/N | 09/N | 092N | Q92N | 09/N | 092N | C9ZN | C92N | G9ZN | G9/W |
| V68A | V68A | H170 | V68A | V68A | V68A | V68A | Q12R | V68A | V68A | V68A | V68A | V68A | V68A | V68A | V68A | V68A | V68A |

| 0 05 | 0 03 | 0.58 | 0.13 | 1.73 | 1.13 | 22 | 0.8 | 1.5 | 0.15 | 1.09 | 0.99 | 1.76 | 1.06 | 1.92 | 1.45 | 1.72 | 1.59 |
|-------|-------|--------|---|-------|-------|--------|-------|-------|-----------------|--------|--------|---|-------|-------|-------|-------|--------|
| 3,34 | 3.28 | 2.91 | 2.86 | 1.30 | 1.83 | 128 | 3.72 | 0.0 | 1.97 | 1.92 | 3.57 | 1.74 | 3.15 | 2.33 | 1.67 | 2.16 | 2.77 |
| | | | *************************************** | TZ60A | | ****** | | 7 | William Control | | | *************************************** | | Q245R | | | \$259G |
| | Q245R | | Q245R | Q245R | | Q245R | 12577 | | | | Q245R | Q245R | Q245R | Q236H | Q245R | Q245R | Q245R |
| Q245R | Q236H | Q245R | Q236H | Q236H | | Q236H | Q245R | | | 1.2577 | Q236H | O236H | Ф236Н | A232V | Q236H | Q236H | Q236H |
| Q236H | N218D | Q236H | V203A | A232V | | A232V | Q236H | L257V | | Q245R | A232V | A232V | A232V | Y214L | A232V | A232V | A232V |
| N204D | G159D | A232V | A1941 | T213R | | P210R | A232V | Q245R | | Q236H | Y209W | G211R | G211V | G159D | A215R | G159D | G159D |
| G159D | A133V | G159D | C8515 | G159D | V1041 | G159D | G159D | Q236H | R275H | A232V | G65150 | G159D | G159D | V104I | G159D | V104I | V104I |
| V104I | V1048 | 7104 | V104I | V104I | S103A | V104 | V104 | A232V | L257V | G159D | V104! | V1048 | V104I | S103A | V1041 | S103A | S103A |
| S103A | S103A | \$103A | S103A | S103A | N76D | S103A | S103A | V104 | V104I | V104I | S103A | \$103A | S103A | US/N | S103A | N78D | Q9/N |
| 09/N | G9/N | N76D | 092N | C97N | V68A | N76D | M76D | S103A | S103A | S103A | 09/N | G92N | N76D | V68A | 09/N | V68A | V68A |
| V68A | V68A | V68A | V68A | V68A | T22K | V68A | V68A | 09ZN | M76D | D97N | V68A | V68A | V68A | Q12R | V68A | Q12R | G20R |

| 43 | 0.68 | 1.37 | 1.2 | 0.76 | 1.86 | 1.44 | 4. | 1.29 | 1.83 | 1.53 | 1.72 | 1.62 | 1.08 | 2 | 1.23 | 1.65 | 0.46 |
|-------|---|-------|--------|-------|-------|---|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|
| 2.62 | 2.92 | 2.17 | 0.48 | 2 92 | 2.09 | 0.51 | 4.80 | 135 | 1.92 | 1.17 | 2.01 | 2.09 | 3.00 | 2 | 1.01 | 0.57 | 0.86 |
| | *************************************** | | | | | | | | | | | | | Q245R | | | |
| T260V | | - | | - | Q245R | | | K251R | A272S | Q245R | | | | O236H | | | |
| Q245R | NZ61G | N261W | | Q245R | Q236H | | | N248S | Q245R | O236H | S256R | Q245R | Q245R | A232V | | | |
| Q236H | Q245R | Q245R | | Q236H | A232V | *************************************** | Q245R | Q245R | Q236H | A232V | Q245R | Q236H | Q236H | N185S | | | |
| A232V | O236H | О236Н | Q245R | A232V | G159D | | Q236H | О236Н | A232V | Q206L | Q236H | A232V | A232V | R170S | | | |
| G159D | A232V | A232V | S242P | P210L | V104 | Q245R | A232V | A232V | G159D | N183K | A232V | Q206R | G159D | G159D | | H249R | |
| V104I | G159D | G159D | Q236H | G159D | S103A | Q236H | Y192F | G159D | V104I | G159D | G159D | G159D | V104I | N116T | Q245R | M222S | M222S |
| S103A | V1041 | V104 | A232V | V104I | U36N | A232V | G159D | V147I | S103A | V104I | V104I | V104! | S103A | V104I | M2228 | V104I | N173R |
| S87R | S103A | S103A | V104I | S103A | V68A | V104 | V104 | V104I | N76D | \$103A | S103A | S103A | 09/N | S103A | V104I | S103A | V104I |
| N76D | U22N | U36D | \$103A | M76D | A48V | S103A | S103A | S103A | V68A | C9ZN | G92N | 09/N | V68A | N76D | S103A | N76D | S103A |
| V68A | V68A | V68A | Q9/N | V68A | Q12R | Q9/N | D97N | D97N | Q12R | V68A | V68A | V68A | K27R | V68A | M76D | O12R | 09/N |

| 0.77 | 0.76 | 116 | 12 | 96.0 | 1.25 | 1.01 | 1.46 | 1.56 | 174 | 1.56 | 1.61 | 1.85 | 1.56 | 1.30 | 1.30 | 0.16 | 0.04 |
|----------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------------|
| 1.24 | 1.18 | 0.52 | 0.56 | 0.43 | 0.42 | 1.15 | 0.53 | 0.69 | 99.0 | 0.52 | 0.70 | 0.79 | 0.78 | 1.25 | 1.29 | 1.44 | 2.01 |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | - | | | | Q245R |
| | | | | | | | | | | | | | L262S | | | K251Q | N243D Q245R |
| | | | | | | | | | | | | Q245R | Q245R | N261D | | Q245R | M222S |
| 4.000.00 | Y263F | | | | | | | | Q245R | Q245R | Q245R | M2228 | V227A | Q245R | | M2225 | N185D |
| | K237R | | E271D | | | | Q245R | | V244! | P210T | M222S | A215V | M222S | M222S | 0245R | S130T | R170S |
| Y263F | M2228 | M2228 | M2228 | M222S | M222S | H249R | M222S | Q245R | W2228 | M2225 | S130T | S130T | S130T | S130T | M222S | 11041 | S130T |
| M222S | V104I | Q109R | Q109R | V104 | Q137R | M222S | V104 | A232V | 20 | V104I | 11047 | 11047 | 11047 | 11047 | S130T | S103A | 11047 |
| V1041 | S103A | V1041 | V104I | S103A | V104I | V104 | S103A | V104 | S103A | S103A | S103A | S103A | S103A | S103A | 1104T | G9/N | S103A |
| S103A | N76D | S103A | S103A | N76D | S103A | S103A | N76D | S103A | N76D | 09/N | D97N | N76D | N76D | N76D | S103A | S57P | N76D |
| N76D | 1.2.1M | N76D | N76D | G61R | N76D | N76D | Q12R | N76D | Q12R | Q12R | Q12R | Q12R | Q12R | Q12R | N76D | Q12R | Q12R |

| 1.60 | 1.56 | 2.09 0.86 |
|-----------------------|------------------------------|----------------------------|
| 0.77 | 0.73 | 2.09 |
| | | |
| | | |
| | | 2.09 |
| V268A | Q245R | Q245R |
| A222S Q245R V268A | M222S P210S Q245R | Q236H |
| 45.4 | | A232V |
| S 13 | N76D S103A 1104T S130T M222S | N76D S103A V104I G159D A23 |
| N76D S103A 1104T | 11047 | V104I |
| S103A | S103A | S103A |
| | 1 | _i |
| Q12R | 012R | V68A |

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Example 3

Table 6 lists the variant proteases assayed from Example 1 and the results of testing in four different detergents. The same performance tests as in Example 2 were done on the noted variant proteases with the following detergents. For column A, the detergent was 0.67 g/l filtered Ariel Ultra (Procter & Gamble, Cincinnati, OH. USA), in a solution containing 3 grains per gallon mixed Ca²⁺/Mg²⁺ hardness, and 0.3 ppm enzyme was used in each well at 20°C. For column B, the detergent was 3.38 g/l filtered Ariel Futur (Procter & Gamble, Cincinnati, OH, USA), in a solution containing 15 grains per gallon mixed Ca2+/Mg2+ hardness, and 0.3 ppm enzyme 10 was used in each well at 40°C. For column C. 3.5g/l HSP1 detergent (Procter & Gamble, Cincinnati. OH, USA), in a solution containing 8 grains per gallon mixed Ca²⁺/Mg²⁺ hardness, and 0.3 ppm enzyme was used in each well at 20°C. For column D. 1.5 ml/l Tide KT detergent (Procter & Gamble, Cincinnati, OH, USA), in a solution containing 3 grains per gallon mixed Ca²⁺/Mg²⁺ hardness, and 0.3 ppm 15 enzyme was used in each well at 20°C.

| ۵ | - | 1,26 | 2,35 | 1,19 | 1,31 | 2.02 | 2.70 | 0.80 | 2.88 | 1.78 | 2.07 | 2.01 | 2.66 | 2.78 | 0.75 |
|---------|---|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Ü | - | 1.39 | 1,65 | 1.20 | 1.86 | 1.60 | 1.48 | 1.23 | 1,41 | 1,55 | 1,63 | 1.62 | 38 | 1.27 | 1.31 |
| <u></u> | - | 1.41 | 1.49 | 1.4.1 | 1.72 | 1.38 | 0.91 | 1.39 | 0.86 | 1.43 | 1.43 | 1.47 | 0.56 | 0.50 | 1.38 |
| ∢. | - | 1.44 | 2.34 | 1.05 | 1.81 | 2.19 | 2.91 | 0.93 | 2.67 | 2.22 | 2.30 | 2.31 | 2.63 | 2.75 | 1.11 |
| | | | | | | | | | N252K | | | | | | |
| | - | <u> </u> | × | × | * | × | × | × | 4 | × | × | × | × | × | - |
| | - | | N252K | N252K | N252K | N252K | N252K | N252K | N248D | N252K | N252K | N252K | N252K | N252K | |
| | *************************************** | *************************************** | N248D | N248D | N248D | N246D | N248D | N248D | Q245R | N248D | N248D | N248D | N248D | N248D | N252K |
| | | N252K | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q236H | Q245R | Q245R | Q245R | 0245R | Q245R | N248D |
| | | N248D | Q236H | Q236H | Q236H | О236Н | O236H | O236H | A232V | Q236H | Q236H | Q236H | Q236H | Q236H | Q245R |
| | | Q245R | A232V | A232V | A232V | A232V | A232V | A232V | P210L | A232V | A232V | A232V | A232V | A232V | O236H |
| | | Q236H | Y209W | G159D | G159D | Y209F | N185D | P210R | N185D | P210L | S212C | S212G | S212E | T213E | A232V |
| | | A232V | G159D | Q109R | V104i | G159D | T2138 |
| | V104I | G159D | 2102 | V104I | S103A | V104i | V104I | V104I | V104i | V104 | V104I | V104I | V104I | V104 | V104I |
| | S103A | V104E | S103A | S103A | V68A | S103A |
| | Q9/N | S103A | V68A | V68A | GZOR | V68A |

| 2.01 | 1.06 | 1.54 | 1.20 | 1.56 | 1.87 | 2.89 | 2.42 | 0.95 | 2.42 | 1.85 | 3.22 | 1.72 | 1.65 | 2.58 | 0.94 | 1.05 | 1.18 |
|-------------|-------|-------|-------|-------|--------|--------|-------|--------|-------|--------|-------|-------|-------|-------|-------|-------|-------|
| 1.12 | 1.37 | 1.53 | 1.47 | 1.56 | 1.47 | 1.07 | 1 29 | 1.24 | 1.42 | 1.30 | 1.43 | 1.58 | 1.59 | 1.33 | 1,46 | 131 | 0.85 |
| 0.15 | 1,42 | 1,40 | 1.58 | 1.36 | 1.36 | 0.33 | 0.46 | 1.46 | 1.00 | 1,13 | 0.91 | 1.36 | 1.46 | 0.77 | 1.52 | 1.41 | 1.41 |
| 2.27 | 1.37 | 2.14 | 1.22 | 2.12 | 1.88 | 2.24 | 2.43 | 0.98 | 2.52 | 2.05 | 2.61 | 2.18 | 2.14 | 2.46 | | 1.21 | 1.51 |
| | | | | | | | | | | | | | | | | | |
| N252K | N252K | N252K | N252K | N252K | N252K | N252K | NZSZK | N252K | | | N252F | T255V | S256N | S256E | S256R | T260R | L257R |
| N248D | N248D | N248D | N248D | N248D | N248D | N248D | N248D | N248D | N252F | N252L | N248D | N252K | N252K | N252K | N252K | N252K | N252K |
| Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | 0245R | Q245R | N248D | N248D | Q245R | N248D | N248D | N248D | N248D | N248D | N248D |
| Q236H Q245R | Q236H | Q236H | Q236H | Q236H | Q238H | O236H | Q236H | Q236H | Q245R | Q245R | Q236H | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R |
| A232V | A232V | A232V | A232V | A232V | A232V | A232V | A232V | A232V | Q236H | C236H | A232V | Q236H | Q236H | Q236H | Q236H | Q236H | Q236H |
| T213E | T213R | A215V | A215R | S216T | \$2167 | \$216C | N173D | OZDBR | A232V | A232V | G159D | A232V | A232V | A232V | A232V | A232V | A232V |
| G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | V104I | G159D | G159D | G159D | G159D | G159D | G159D |
| V104I | V104I | V104I | V104I | V104I | V104I | V104I | V1041 | V104I | V104I | V104I | S103A | V104I | V104I | V104I | V104I | V104f | 14017 |
| A103V | S103A | S103A | S103A | S103A | S103A | S103A | S103A | \$103A | S103A | \$103A | V68A | S103A | S103A | S103A | S103A | S103A | S103A |
| V68A | V68A | V68A | V68A | VBBA | V68A | V68A | V68A | V68A | V68A | V68A | P55S | V68A | V68A | V68A | V68A | V68A | V68A |

| Q245R N246D N252K N261R 1.02 1.47 1.37 ND40RD ND50X 1.04 1.60 1.47 1.37 | 102 1 50 1 1 CO | | Q236H Q245V N248D N252K 2.60 0.93 1.41 2.67 | A232V Q236H Q245R N248D N252K | G159D A232V Q236H Q245K N248D N252K 2.83 0.25 1.33 2.44 | A232V Q236H Q245R N248D N252K 2.10 0.97 1.36 2.29 | O236H O245R N248G N252K 1.27 | A232V Q236H Q245R N248D N252K 2.30 1.50 1.62 1.56 | A232V Q236H G245R N248D N252K 1.72 1.72 1.67 1.15 | G159D P210L T213R A232V Q236H Q245R T260A 1.32 1.30 1.11 1.28 | A232V O236H G245R N248D N252K 2.50 0.83 1.43 2.25 | \$160V A232V Q236H Q245R N248D N252K 4 20 0.07 ND 1.28 | V1041 A232V Q236H Q245R N248D N252K 3.47 0.60 ND 1.45 | Y167F A232V Q236H Q245R N248D N252K 4.32 0.79 ND 1.55 | Q236H Q245R N248D N252K 3.14 0.41 ND 1.40 | 0236H 0245R N248D N252K 271 0.68 ND 1.72 | ~ |
|---|-----------------|-------|---|-------------------------------|---|---|------------------------------|---|---|---|---|--|---|---|---|--|--|
| 261R 252K | 1252K | 1252K | 252K | - | | 252K | | 1252K | 252K | | 252K | · | | <u> </u> | | | Constitution of the same of th |
| | N252K | N252K | | ÷ | i | | N252K | | <u> </u> | | | 4 | . | . j | N252K | N252K | |
| ļ | *** | N252K | <u>-</u> | <u>.</u> | | Q245R | N248G | Q245R | Q245R | T213R | Q245R | Ф236Н | · | | N248D | N248D | - Constitution of the Cons |
| LJ ZZ CO | CZ437 | N248D | 02450 | Q236H | A232V | Q236H | Q245R | Q236H | Q236H | P210L | O236H | A232V | A232V | A232V | Q245R | Q245R | Annual Contraction of the Contra |
| | Q236H | Q245R | Q236H | A232V | G159D | A232V | Q236H | A232V | A232V | G159D | A232V | \$160V | V104I | Y167F | Q236H | Q236H | |
| Proposition and an arrangement | A232V | Q236H | A232V | A228V | S130A | G159D | A232V | N218S | G159D | V104I | G159D | G159D | S103A | G159D | A232V | A232V | |
| | G159D | A232V | G159D | G159D | V104 | A133V | G159D | G159D | V104I | S103A | V104I | V104I | 092N | V104I | G159D | G159D | ~ |
| | V104E | V104I | V104 | V104I | S103A | V104i | V104i | V 1041 | S103A | C683 | S103A | S103A | V68A | S103A | V104! | V1041 | - |
| | S103A | S103A | S103A | \$103A | V68A | S103A | S103A | S103A | V68A | Q9/N | Q9/N | V68A | G61E | V68A | S103A | S103A | - |
| | V68A | V68A | V68A | V68A | GB1E | G61E | V68A | V68A | G20R | V68A | V68A | G61E | S3L | G61E | G97E | A98D | |

| | | | | | | | 86 | , | | | | | | | | | |
|-------------------|----------|-------|-------|-------|-------|----------|-------|-------|--------------|---------------------|-------------------|-------------|-------|-------|-------|-------|-------------------------|
| 1.90 | 1.33 | 1.69 | 2.71 | 2.40 | 2.58 | 1.82 | 2.46 | 2.84 | 3.97 | 3 08 | 2.60 | 2.54 | 1.10 | 2.55 | 2.40 | 1.86 | 385 |
| 9 | 2 | 2 | 2 | 2 | Q | 2 | 9 | 2 | 2 | 2 | 9 | 2 | 2 | Q | 2 | 2 | g |
| 0.27 | 1.80 | 1.33 | 0.55 | 1.05 | 2.19 | 2,16 | 0.13 | 1.36 | 1.21 | 0.95 | 2.83 | 1.92 | 2.61 | 2.46 | 2 08 | 2.04 | 2.11 |
| 3.50 0.27 | 2.24 | 3.35 | 4.88 | 4.22 | 5.45 | 3.76 | 7.42 | 5.43 | 5.12 | 6.38 | 3.17 | 4.38 | 3.05 | 4.09 | 2.32 | 2.34 | 2.24 |
| | | - | | | | | | | | | N252K | - | | | | | |
| | - | - | - | - | - | <u> </u> | - | - | - | + | ·•}~~~~ | * | * | × | - | - | + |
| | <u> </u> | ļ | - | | _ | | | ļ | <u> </u> | _ | N24 | N252K | N252K | N252K | | - | |
| N252K | N252K | NZ5ZK | N252K | N252K | N2618 | N252K | N252K | N252K | M252K | M252K | Q245R | N248D | N248D | N248D | N252K | N252K | N252K |
| Q245R N248D N252K | N248D | N248D | N248D | N248D | N252K | N248D | N248D | N248D | ·• | ~ j ~~~~ | Q236H Q245R N248D | | Q245R | Q245R | N248D | N248D | N248D |
| | Q245R | O245R | Q245R | Q245R | N248D | Q245R | Q245R | Q245R | Q245R N248D | Q245R N248D | A232V | Q236H Q245R | Q236H | О236Н | 0245R | Q245R | Q245R |
| Q236H | Q236H | Q236H | Q236H | Q236H | Q245R | Q236H | Q236H | Q236H | Q236H | Q236H | T213R | A232V | A232V | A232V | Q236H | V244T | Q236H V244A Q245R N248D |
| A232V | A232V | A232V | A232V | A232V | Q236H | A232V | A232V | A232V | A232V | A232V | G159D | T213R | L217E | Q206R | A232V | Q236H | Q236H |
| G159D | G159D | G159D | G159D | G159D | A232V | G159D | G159D | N184D | S166D | 1217E | V104I | G159D | Q206R | G159D | N184G | A232V | A232V |
| V104 | V104I | V104I | S108E | Q109E | G159D | Q109R | V104! | G159D | G159D | G159D | S103A | V104 | G159D | V104I | G159D | G159D | V104 G159D A232V |
| S103A | S103A | S103A | V104I | V 104 | V104 | V104I | S103A | V104I | V104! | V1041 | N62D | S103A | V1041 | S103A | V104I | V104I | |
| S101E | S101G | G102A | S103A | S103A | S103A | S103A | N62D | S103A | S103A | S103A | GZOR | N62D | S103A | N62D | S103A | S103A | S103A |

| 2.47 | 1.82 | 1,44 | 66 | 5,39 | 1.92 | 1.36 | 1,01 | 2.88 | 3.84 | 3,19 | 2.17 | 2.25 | 2.08 | 2.25 | 2.34 | 1.86 | 1.49 |
|----------|-------|-------|---|-------------|--------------|-------|----------|-------------|--|--------------|-------|-------------|-------|-------|-------|-------|----------|
| | 9 | ┼ | <u>Q</u> | | | ┼ | <u>2</u> | 2 Q | | | ND 2 | + | 2 | 2 | 2 | 2 | 2 |
| 2 | | 2 | | 2 | 8 | 2 | ļ | L | 8 | 2 | ļ | 2 | - | 1 | 1 | 1 | <u>.</u> |
| £ 58 | 2.09 | 2.66 | 2.78 | 0.84 | 1.41 | 0.57 | 1.86 | 0.50 | 1.20 | 2.10 | 2.67 | 0.41 | 2.07 | 2.48 | 2.76 | 2.10 | 2.35 |
| 63 63 | 2.30 | 2.63 | 2.01 | 7.74 | 5.14 | 4.97 | 2.41 | 4.42 | 5.86 | 5.87 | 2.98 | 4.02 | 6.63 | 2.03 | 2.96 | 2.74 | 2.11 |
| | | | *************************************** | E2710 | | | | | | | | | | | | | |
| | | | | N252K | | | | | | - | | | | | | | |
| | | S256R | N252K | N248D | | | | | Control of the Contro | | N252K | N252K | N252K | | N252K | | |
| | | N252K | N248D | Q245R | N252K | N252K | N252K | N252K | N252K | N252K | N248D | N248D | N248D | NZSZK | N248D | | |
| M252K | N252K | N248D | Q245R | Q236H | N248D | N248D | N248D | N248D | N248D | N248D | Q245R | | Q245R | N248D | Q245R | | |
| N248D | N248D | Q245R | Q236H | A232V | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | О236Н | Q236H Q245R | Q236H | Q245R | Q236H | | |
| Q245R | Q245R | Q236H | A232V | 7213R | Q236H | C236H | Q236H | Q236H Q245R | Q236H | Q236H Q245R | A232V | A232V | A232V | Q236H | A232V | N252K | |
| Q236H | C236H | A232V | T213R | Q206E | A232V | A232V | A232V | A232V | A232V | A232V | S212G | \$2126 | S212G | A232V | T213R | N248D | |
| A232V | A232V | T213R | G159D | N1850 | N185D | Q206E | T213Q | G159D | G159D | S212G | G159D | G8919 | G8515 | T213R | G159D | Q245R | Q245R |
| G159D | G159D | G159D | V104I | G158D | G159D | G159D | G159D | V104I | V104I | G159D | V1041 | V1048 | V104I | G159D | Q109R | AZ3ZV | A230V |
| V104 | V104I | V104I | S103A | V104I | V104! | V104i | V1041 | S103A | S103A | V104I | S103A | S103A | S103A | V104£ | V104! | G159D | G159D |
| S103A | S103A | S103A | N62D | S103A | S103A | S103A | S103A | G102A | G102A | S103A | G102A | G102A | G102A | S103A | S103A | V104E | V104I |
| K27N | T38G | N62D | Q12R | N62D | S101G | S101G | \$101G | ASBL | \$1016 | G102A | Q12R | A98L | S101G | G102A | N62D | S103A | S103A |

| 2.58 | 1.61 | 0.6 | 1.08 | 2.35 | 1.77 | 1.45 | 3.05 | 1.08 | 1.20 | 20. | 8.7 | 1.03 | 1,05 | 1.23 | 1,10 | 1.25 | 2 |
|--------|----------|--------|---|--------|--------|--------|--------|--------|--------|---------|-------|--------|--------|---|---------|---------|----------|
| 2 | S S | Q | Q. | ND Z | 8 | S S | Q Q | 2 | Q | Q | Q | 2 | 9 | 9 | 2 | 9 | 128 |
| 0.71 | 1.32 | 1.23 h | 0.71 N | 0.83 | 1.38 h | 0.07 | 1.16 | 1.34 | 1.47 h | 1.38 | 1.18 | 1.23 h | 1.38 | 1.51 | 1.30 | 0.80 | ~ |
| | <u> </u> | ļ | ÷ | ÷ | | Amm | A | | 2.16 | 1,79 1. | 1.15 | in. | 1.90 | 1.55 | 1.96 1. | 2.49 0. | <u> </u> |
| 3.42 | 2.59 | 1.30 | 2.94 | 3.17 | 2.15 | 3.07 | 2.26 | 1.82 | 2.1 | 1.7 | 1. | 1.47 | 5.5 | 5. | 135 | 2.4 | 420 |
| ****** | | | | | | | | | | | | | | | | | |
| N252K | | | *************************************** | NZSZK | NZ52K | N252K | | | | | | | | | | N252K | N252K |
| N248D | N252K | N252K | N252K | N248D | N248D | N248D | N252K | N252K | N252K | NZ52K | N252K | N252K | N252K | *************************************** | N252K | N248D | N248D |
| Q245R | N248D | N248D | N248D | Q245R | Q245R | Q245R | N248D | N248D | N248D | N248D | N248D | N248D | N248D | | N248D | Q245R | Q245R |
| Q236H | Q245R | Q245R | Q245R | Q236H | Q236H | C236H | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | | Q245R | O236H | Q236H |
| A232V | Q236H | Q236H | Q236H | A232V | A232V | A232V | Q236H | Q236H | Q236H | Q236H | Q236H | Q236H | Q236H | Q245R | Q238H | A232V | A232V |
| T213R | A232V | A232V | A232V | T213R | T213R | T213R | A232V | A232V | A232V | A232V | A232V | A232V | A232V | Q236H | A232V | A194P | \$160V |
| G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | \$212G | Y209W | P210I | V205I | A230V | A194P | G159D | G159D |
| S130G | \$130G | S128G | S128L | V1041 | S128G | S128L | P131V | V1048 | V104! | G159D | G159D | G159D | G159D | G159D | G159D | V104I | V104I |
| V1041 | V104 | V104 | V104 | S103A | V104I | V104 | V104 | S103A | S103A | V104 | 12017 | V104I | V104I | V104 | V1048 | S103A | \$103A |
| S103A | S103A | \$103A | S103A | \$1016 | S103A | S103A | S103A | \$1016 | \$1016 | S103A | S103A | S103A | \$103A | S103A | S103A | \$1016 | V68A |
| N62D | S101G | S101G | S101G | N62D | N62D | N62D | \$1016 | A98V | 899G | Store | S101G | S101G | S101G | Store | \$1016 | N76D | G61E |

| 9 | | | | | | | | 89 | | | | | | | PCT | 7089 | 98/22: |
|-------|-------|-------|-------|-------|-------|-------|----------------|--------|-------|-------|---|-------|--------|--------|--------|-------------|-------------|
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | g | 2 | 2 | 2 | 9 | 9 | 9 | 2 | 2 |
| 45 | 155 | 140 | 172 | 171 | 180 | 133 | 169 | 27.1 | 240 | 258 | 182 | 246 | 284 | 397 | 308 | 260 | 254 |
| 8 | 7.9 | 41 | 68 | 68 | 27 | 180 | 133 | 55 | 105 | 219 | 216 | 13 | 136 | 121 | 35 | 283 | 192 |
| 347 | 432 | 314 | 271 | 297 | 350 | 224 | 335 | 488 | 422 | 545 | 376 | 742 | 543 | 512 | 638 | 317 | 438 |
| | | | | | | | | | | | | | | | | | |
| N252K | NZ52K | • | | | | | ************** | | | | *************************************** | | | | - | N252K | |
| N248D | N248D | | | | | | | | | | | | | | | N248D | N252K |
| Q245R | Q245R | N252K | N252K | N252K | M252K | N252K | N252K | N252K | N252K | N261R | N252K | N252K | N252K | N252K | N252K | Q245R N248D | N248D N252K |
| Q236H | Q236H | N248D | N248D | N248D | N248D | N248D | N248D | N248D | N248D | N262K | N248D | N248D | N248D | N248D | N248D | Q236H | Q236H Q245R |
| A232V | A232V | O245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | N248D | C245R | Q245R | Q245R | Q245R | Q245R | A232V | Q236H |
| V104I | Y167F | Q236H | Q236H | Q236H | Q236H | Q236H | Q236H | Q236H | Q236H | Q245R | Q236H | Q236H | Q236H | Q236H | Q236H | T213R | A232V |
| S103A | G159D | A232V | A232V | A232V | A232V | A232V | A232V | A232V | A232V | Q236H | A232V | A232V | A232V | A232V | A232V | G159D | T213R |
| 09/N | V104I | G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | A232V | G159D | G159D | N184D | S166D | L217E | V104 | G159D |
| VSSA | S103A | V1041 | V104i | V104I | V104 | V104I | V104 | \$106E | Q109E | G159D | Q109R | V104I | G159D | G159D | G159D | \$103A | V104 |
| G61E | V68A | S103A | S103A | S103A | S103A | S103A | S103A | V1048 | V104! | V104I | V104I | S103A | V104I | V104f | V104! | N62D | S103A |
| S3L | G61E | G97E | A98D | 366S | STOTE | S101G | G102A | S103A | S103A | S103A | S103A | N62D | \$103A | \$103A | \$103A | GZOR | N62D |

| 2 | 2 | Q | 9 | 9 | 2 | S | 2 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
|--------------|-------|--------------|-------|----------------------|-------|--------|-------------|-------|-------------|-------|-------|-------|-------|-------|--------|---|--------|
| 2 | 255 | 240 | 186 | 195 | 247 | 182 | 144 | 199 | 539 | 192 | 136 | 101 | 288 | 384 | 313 | 217 | 225 |
| 281 | 246 | 208 | 204 | 211 | 156 | 209 | 266 | 278 | 26 | 141 | 27 | 186 | 90 | 120 | 210 | 267 | 41 |
| 88 | 409 | 232 | 234 | 224 | 281 | 230 | 263 | 201 | 774 | 514 | 497 | 241 | 442 | 586 | 587 | 298 | 402 |
| | | - | | SALAMA AT SALESANDER | | | | | £2710 | | | - | | | - | *************************************** | |
| | | | | | | | | | N248D N252K | | | | | | | | |
| | | | | | | - | S256R | N252K | N248D | | | | | | | N252K | N252K |
| N252K | NZ52K | - | | | | | N252K | N248D | Q245R | NZ52K | N252K | N252K | N252K | NZ52K | N252K | N248D | N248D |
| N248D | N248D | N252K | N252K | N252K | NZ52K | N252K | N248D N252K | Q245R | Q236H Q245R | N248D | N248D | N248D | N248D | N248D | N248D | Q245R | Q245R |
| Q245R | Q245R | N248D | N248D | N248D | N248D | N248D | O245R | Q236H | A232V | Q245R | Q245R | Q245R | Q245R | Q245R | Q245R | O236H | Q236H |
| Q236H | Q236H | Q245R | Q245R | Q245R | Q245R | Q245R | О236Н | A232V | T213R | Q236H | Q236H | Q236H | Q236H | Q236H | Q236H | A232V | A232V |
| A232V | A232V | Q236H | V244T | V244A | O236H | Q236H | A232V | T213R | Q206E | A232V | A232V | A232V | A232V | A232V | A232V | \$212G | \$2126 |
| L217E | Q206R | A232V | Q236H | Q236H | A232V | A232V | T213R | G159D | N185D | N185D | Q206E | 72130 | G159D | G159D | \$212G | G159D | G159D |
| Q206R | G159D | N184G | A232V | A232V | G159D | G159D | G159D | V104[| G159D | G159D | G8915 | G159D | V104I | V104f | G159D | V104f | V104f |
| G159D | V104I | G159D | G159D | G159D | V104 | V:104I | V104I | S103A | V104I | V104I | V104I | V104 | S103A | S103A | V104I | S103A | S103A |
| 210 <u>2</u> | S103A | Z10 <u>Z</u> | V104I | V104I | S103A | S103A | S103A | N62D | S103A | S103A | S103A | S103A | G102A | G102A | S103A | G102A | G102A |
| S103A | N62D | S103A | S103A | S103A | K27N | T38G | N62D | Q12R | N62D | S101G | S101G | S101G | A98L | S101G | G102A | Q12R | A981. |

| 2 | 2 | 2 | 9 | 2 | 2 | 9 | 9 | Q | Ş | 9 | 9 | Q | g | 2 | 2 | 9 | g |
|--------|---|--------|-------|---|-------|-------|-------|--------|-------------|-------------|-------|----------|-------|--------|-------|-------|-------------|
| 208 | 225 | 234 | 186 | 149 | 258 | 161 | 90 | 108 | 235 | 177 | 145 | 305 | 108 | 120 | 101 | 87 | 103 |
| 207 | 248 | 278 | 210 | 235 | 77 | 132 | 123 | 77 | 22 | 138 | 7 | 118 | 13 | 147 | 138 | 118 | 123 |
| 963 | 203 | 296 | 274 | 211 | 342 | 259 | 130 | 294 | 317 | 215 | 307 | 528 | 182 | 216 | 179 | 115 | 147 |
| | | | | | | | | | | | | | | | | | |
| N252K | *************************************** | N252K | | *************************************** | N252K | - | | | N252K | N252K | N252K | | | | - | | |
| N248D | N252K | N248D | | | N248D | N252K | N252K | N252K | N248D | N248D | N248D | N252K | N252K | N252K | N252K | N252K | M252K |
| Q245R | N248D | Q245R | | | Q245R | N248D | N248D | N248D | Q245R | 0245R | Q245R | N248D | N248D | N248D | N248D | N248D | N248D |
| Q236H | Q245R | O236H | | | O236H | Q245R | Q245R | Q245R | O236H Q245R | | Q236H | Q245R | O245R | Q245R | Q245R | 0245R | Q245R |
| A232V | Q236H | A232V | N252K | | A232V | Q236H | Q236H | C238H | A232V | A232V Q236H | A232V | Q236H | Q236H | Q236H | Q236H | Q236H | |
| S212G | A232V | T213R | N248D | | T213R | A232V | A232V | A232V | T213R | T213R | T213R | A232V | A232V | A232V | A232V | A232V | A232V Q236H |
| G159D | T213R | G159D | Q245R | Q245R | G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | G159D | S212G | Y209W | P2101 |
| V104I | G8\$15 | Q109R | A232V | A230V | S130G | S130G | S128G | \$128L | V1048 | S128G | S128L | P131V | V1041 | V1041 | G159D | G159D | G159D |
| S103A | V104 | V104 | G159D | G159D | V1041 | V1041 | V104! | V104I | S103A | V104 | V104I | ₹ 104 | S103A | S103A | V104I | V104I | V104I |
| G102A | S103A | \$103A | V104i | V104! | S103A | S103A | S103A | S103A | S101G | S103A | S103A | S103A | S101G | \$1016 | S103A | S103A | S103A |
| \$1016 | G102A | OZ9N | S103A | S103A | N62D | S101G | 81016 | S101G | N62D | N62D | N62D | \$1016 | A98V | 9668 | S101G | S101G | S101G |

| 2 | Ş | Ş | 2 |
|---|---|---|---|
| 105 | 123 | 110 | 125 |
| 190 138 105 ND | 155 151 123 ND | 196 130 110 ND | 249 80 125 ND |
| 130 | 155 | 196 | 249 |
| | | | |
| | | | |
| | | | |
| N252K | | N252K | N252K |
| N248D | | N248D | N248D |
| Q245R | | Q245R | Q245R |
| Q236H | Q245R | O236H | Q236H |
| A232V | Q236H | A232V | A232V |
| V205I | A230V | A194P | G159D |
| G159D | G159D | G159D | V104I |
| V104I | V104 | V104I | S101G S103A V104 G159D A232V Q236H Q245R N248D |
| S101G S103A V104I G159D V205I A232V Q236H Q245R N248D | \$101G \$103A V104I G159D A230V Q236H Q245R | S101G S103A V104I G159D A194P A232V Q236H Q245R N246D N252K | S101G |
| \$101G | S101G | S101G | D92N |

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WHAT IS CLAIMED:

- A protease variant comprising replacing an amino acid at one or more residue positions corresponding to residue positions selected from the group consisting of 62, 212, 230, 232, 252 and 257 of Bacillus amyloliquefaciens subtilisin.
- The protease variant according to claim 1 which is derived from a Bacillus subtilisin.
- The protease variant according to claim 2 which is derived from Bacillus lentus subtilisin.
 - 4. A DNA encoding a protease variant of claim 1.
- 15 5. An expression vector encoding the DNA of claim 4.
 - 6. A host cell transformed with the expression vector of claim 5.
 - 7. A cleaning composition comprising the protease variant of claim 1.

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- 8. An animal feed comprising the protease variant of claim 1.
- A composition for treating a textile comprising the protease variant of claim 1.

25

- 10. The protease variant according to claim 1 comprising a substitution set selected from the group consisting of residue positions corresponding to positions in Table 1 of Bacillus amyloliquefaciens subtilisin.
- 30 11. The protease variant according to claim 10 comprising a substitution set selected from the group consisting of residue positions corresponding to positions in Table 2 of Bacillus amyloliquefaciens subtilisin.

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12. The proteese variant according to claim 10 comprising a substitution set selected from the group consisting of residue positions corresponding to positions in Table 3 of Bacillus amyloliquefaciens subtilisin.



| | 10C | Med ATG | # Q | 8 2 | 5 8 | A Val |
|--|--|----------------------|-----------------|--------------|-------------------------|------------|
| | ā Ş | ¥29 | O. A. | 3 | 12 Ke | X Z |
| 5 M 5 ST 5 | Ser | PSC WGC | 7 K | 38 | ¥ 85 | 35 |
| WG. | ₹ 00 00 | 8 M S | 24 | 4 1 1 E | 2 E | 25 |
| GATA. | # E | ACA TH | AA K | TAC | SCT AB | \$ £ 50 |
| GAGAG | 8 G | 85 | \$ P | 8 PB | £ 53 | #5 |
| A GG # | Met ATG | \$ \$ | జ్ వే | Val GTC | \$ 00 00 00 00 | Ser |
| WAAA | ACG ACG | 2E | & \$5 \$5 | Ser AGC | \$ \$ | Ser TC1 |
| MATGA | 2E | 90 00 00 00 | 955 | 2CG | a E | \$ 15 |
| 10CA | A TC | CIC | C10 | ASP | ≘జ్వే | AIC |
| ZE ZE | E K | *** | \$ 5 | 5₹ | \$ 5 5 5 | 8 G |
| (Sen | ₽8 | PHO TAT M | 90° | A A | S K | Ser |
| S-E | 夏至 | \$ 52 | ر ورو | Lea 11G | ₹ 9 | CAC CAC |
| 10101 | \$ 55 | Lys ANG | NA Ex | 8 రెక్ | Tyr TAC | # 2 22 |
| ATAA | # E | 3 S | ₩ 50 B | 88 | 8 E | S 7 3 |
| CAGA | 2 2 | è 999 | Z (% | F 25 | Val 616 | \$ 00 |
| IXCA | TE OFF | ASS | AH | # 55 # | 35 | Z Z |
| @~_ <u>\$</u> | \$ E | <u>≩</u> & | 250 | 58 | 88 | 82 |
| TAC | 8 8 Z | 82 | 8 8 8 | 38 | - 3 8 | Kal GH |
| 1467 | £20 | æ 999 | \$ ጀ | ASA | - 52 | AS:n |
| TCCA | Val G1A | eg SS | AAG AAG | E E | ₹ 00 | \$ 2 |
| ATTAI | 53 | # SS | A PS | ACA ACA | 42 | 8 |
| D WAAT | 53 | 58 | Aka GCT | Ala GCT | £ 20 | PP. ACT |
| (4) (4) HBS GGIEGACIAACIAACAATIAAAAAAAAAAAAAAAAAAAAAAAAA | CG CF | 8 8 8 CC | 88 | 8 % 5 | Val | A S |
| 60-100 | \$ \text{\text{\$\langle}{\text{\$\langle}{\text{\$\langle}{\text{\$\langle}{\text{\$\text{\$\langle}{\$\text{\$\exitt{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\exitt{\$\text{\$\exitt{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\exittit{\$\text{\$\exittit{\$\text{\$\exitt{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\e | 10 Se | Ser | \$ 50 | CAC | R & 8 |
| | gr. | * | 249 | 324 | £ | 474 |

FIG._1B-

| SCC 250 | 58 | A TG | \$ OC ¥ | ₹ 00 00 | 8 TO | ₫ 80 6 | # D |
|---------------|---------------|-----------------|----------------|-------------------|--------------|-------------------|--|
| PE E | \$ 5 5 | Asn | S Kal | 85 | ð 6 | \$ & | Asn |
| ¥ 2 | SC \$2 | Asn | SCC SCC | 7.7 | S & | E 25 | A S |
| The ACT | EX | \$ 50 \$ | \$ \$ | 8 | AGC SE | 800 800 800 | 150 100 |
| £ 8 | 835 | A C | 8 & E | G Wall | 885 | £8 | 240 ASn AAC |
| £ 2 | 5 8 5 | ₽ 900 900 | Val GTT | E S | # S | F S | £ 00 |
| Se TO | \$ 2 8 | <u>#</u> 8 | శ్రీ స్ట్ర | AGC SE | Ser | 25 | \$ 50 50 50 50 50 50 50 50 50 50 50 50 50 5 |
| AAC | AGC SW | 3 0 0 | GCG GCG | £ % | 4 8 | ASH | S SS |
| Asp AAC | 25 | A I C | ŠŁ | A GC | AGA AG | ð Š | Ser 7C1 |
| 8 25 2 | ₽₽ 000 | ≘ & § | 13 X | ₹ ₹ 00 00 | చే కే | 22 22 | E 5 |
| జ్ కే | E ES | Asn | S & S | # \$ D | ASS | CIE | 2 E N |
| 128 | ð 8 | # E | SCT AB | Ser ACT ACT | AGC Se | <u>¥</u> 92 | 38 3 |
| Ass CCT | 3 € | ATC | Ser 1CT | ن ورون ورون | Ser | Ser. | ₹8₽ |
| A 25 A | CTA Kai | TIP 100 | 86 | æ 85 85 | \$ 50 CAC | శ్ వే | |
| ACA THE | 2 6 B | Ser | 28.8 | ASI | 825 | ALC ME | 8 8 8 6 |
| 300 | Re ATC | W S | 8 5 | 8 B | ₽ | 3.5 | ð É |
| Ser ICI | <u> </u> | చ్చి కే | æ} 800 | Aga GCC | \$ 50° | A K | ₽ |
| 85 | ASS | æ 9 | æ`8 | ఖ స్ట | ¥2d GTA | 8 | e ea |
| Set Control | \$ \\ | 10°C | 320 | 8 € 600 | 4 8 | 8 5 | ₹ X |
| 88 88 A 1G | 35 | SG € 58 | \$ 50 CC | 2 2 2 C | 2 2 | 8 # 35 8 # 35 | £ 553 |
| AGC AGC | \$ 28 | SA BE | A TG | CIC K | Val | Met ATG | Ser TCT |
| Ata 500 | 88 200 | Asp GCT Asp | A & C | Val GIA | £ 5 | STC CTC | 28 |
| à \$ | E SE | 80 | a H | Kal GTC | 25 | GAT & | ATG ATG |
| a 00 | を変 | SE CHE | e Kar | æ 88 | TAC TA | 35 | \$ Z |
| \$ 8 | 2 d 3 | ST CIT | CAC CAC | 10 SE | 883 | 3 8 | ACG # 23 |
| 523 | 2% | 669 | 72 | 849 | 924 | \$6 | 1074 |

S50 GN 250 GN 25

1316 ATAATCGACGGATGGCTCCCTCGAAAATTTTAACGAGAAAGGCGGGTTGACGGGCTCAGGGCGGTAACGGCCGAAGTGCTGAAACGTCTCAATCGCCG

1416 CTTCCCGGTTTCCCGGTCAQCTCAATGCCGTAACGGTCGGCGGCGTTTTCCTCATACCGGGAAACGGCATTCGTAATCGGATC

FIG._1B-3

FIG_1B-1 FIG_1B-2 FIG_1B-3

CONSERVED RESIDUES IN SUBTILISINS FROM BACILLUS AMYLOLIQUEFACIENS AOSVP.G...APA.H..G 30 TGS.VKVAV.D.G....HP 41 DL...GGAS.VP....QD . N . H G T H V A G T . A A L N N S I G VLGVAPSA, LYAVKVLGA, G 110 SG. S. L. G. EWA. N. . . . 130 V.N.SLG.PS.S....A.. 160 141 150 GV. VVAA. GN. G. ... 161 190 181 D. N. ASPS. G. LD. A PGV..QST.PG..Y...NGT 230 SMA.PHVAGAAAL...K... 250 W...Q.R..L.NT...LG.. 270 261 . . YG . G L . N . . A A . .

FIG._2

| COMPARISON OF SUBTILISIN SEQUENCES FROM B amplotique/aciens B subtilis B subt |
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| 21 24 24 24 | 5 5 5 5 | | 0000 |
|----------------------------|-------------------------------|--------------------|-------------------|
| | ннын | EEEE | ಬಬಬಬ |
| to to to * | 80 80 E4 80 | zz 00 | 8 K K H |
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FIG. 3A

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FIG. 3A

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